A.9.6.

Cable rating using a computer analogue

LYALL J.S., School of Electrical and Electronic Systems Engineering, Brisbane, Australia

Modern computing techniques have put powerful tools in the hands of designers. However commonly available programs are based on the IEC or Neher McGrath methods for calculating cable ratings and these are based on procedures developed for manual calculation. Thus do not provide the full power of computer based techniques. On the other hand the powerful numerical models used for two and three-dimensional thermal modelling of cables are too difficult or expensive to use for normal design or dynamic rating studies. In this paper the shortcomings of the manual based methods and the need and relevance of more sophisticated numerically based models will be examined. Unfortunately because of they are costly and difficulty to use the numerically based programs have only been applied to specialised problems. There is a need for something with the power of the numerical models but which is more accessible to power system designers and operators. This paper describes a technique that could fulfil that need. A description of an application and an outline of the basic theory of this alternative technique are given.

Computer programs for modelling two and three dimensional heat flow allow the simulation of different trench designs and cable groups or flow from cable joints and hot spots along a cable route. Two well-known methods are the finite element method (FEM) and the finite difference method (FDM). These numerical modelling packages work by dividing a body into small elements to which different properties can be assigned, thus providing the ability to accommodate the complex shapes and combination of different materials often found in engineering. The method commonly used in engineering is the FEM as it can more easily accommodate the curved or sloping boundaries often found in engineering. However the development of the FEM requires some sophisticated maths. The FDM method is simpler but is restricted to rectilinear boundaries. The sophisticated maths algorithms together with the necessity of a graphics user interface to hide the details from the user make the development and maintenance of such programs an expensive exercise. Consequently these packages are costly and normally only justified by large organisations that have a clearly define application - such as cable manufacturers seeking competitive advantages or where there is a pressing need to optimise the cable rating.

The alternative approach, referred to here as a Computer Analogue is an outgrowth of techniques use to develop thermal analogues before computers and numerical methods became generally available. The paper will describe the theory that puts these techniques on a rigorous theoretical basis without reference to any calculus. It uses only basic physical concepts and simple algebra to establish the model equations. Elements of any shape can be chosen and a time varying solution obtained. It thus has the flexibility of FEM and simpler to develop than the FDM which is restricted to a rectangular geometry. The paper will describe an application where three dimensional heat flow from a cable in a duct was modelled on a spreadsheet and another application where an engineer was able to develop a two-dimensional model for a dynamic rating study.