Close and Return

DYNAMIC RATING SYSTEMS IN GENERAL AND IN A HIBRID 150 KV TRANSMISSION SYSTEM

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ABSTRACT

In this paper dynamic rating techniques are described, presented, demonstrated and evaluated. Attention is paid to finding thermal bottlenecks in cable circuits, to on-line and off-line applications and to the relation between thermal models and measurements. The possibilities of on-line dynamic rating systems is demonstrated with a pilot project at utility NUON in which a 150 kV connection consisting of an oil filled power cable and an overhead line in series is set up, deployed and verified against real practice. Throughout the paper, attention is paid to the practical application of modern techniques to optimally utilise the possibilities of connections.

KEYWORDS

Dynamic rating, ampacity, thermal bottleneck, hotspot, optimal usage, asset management.

1. INTRODUCTION

The rating of power cables is a very important subject for utilities. After all, power cables are installed to transport power from one place to another in a reliable way. As the transported power is the product of voltage and current, and the voltage is both fixed by the network and tested during installation / commissioning, the current rating of power cables is of great importance.

Utilities have the difficult task to manage many cables, lasting decades. As the ampacity (current carrying capacity) of a cable is usually only determined at the beginning of the lifetime of a cable circuit, ampacity calculations, including their assumptions may have been performed decades ago. In those days, the use of an assumed set of soil conditions and the use of stationary (sometimes simplified) calculations were much more common than nowadays, now that there are ways to determine soil thermal parameters by soil surveys and improved dynamic calculation methods.

With modern techniques, a re-assesment of the ampacity of underground power cables is often advantageous. The thermal inertness of the soil can be used to transport more current than the stationary maximum (the IEC 60287 continuous current rating [1]) without thermally overloading the cable circuit. Techniques are becoming available to determine the actual thermal bottleneck of cable circuits, so that calculations can be focused on the weakest part of the chain [2].

While on the one hand more techniques to assess the true ampacity of power cables are becoming available, on the other hand utilities are forced more and more to transport energy in the most cost-effective way. As nowadays installing a new cable circuit in an increasingly urbanised environment implies increasing permitting times, increasing numbers of HDD crossings and in general increasingly difficult installation procedures, the capital investments in cable circuits increase. If utilities can invest 'just-in-time' in the network because new techniques determining the cable ampacity are used without introducing unmanageable risks at the same time, this is a very interesting way forward.

An example of what can be realised with the techniques mentioned is described in this paper: the realisation of a dynamic rating system of a 150 kV hybrid connection consisting of an oil filled cable and an overhead line, both without direct temperature measurements as is the usual case with power cables [3]. However, this paper also focuses on new techniques and principles regarding dynamic rating, to be specified in paragraphs 3 and 8.

2. THERMAL BOTTLENECK OR HOTSPOT ?

Regarding definitions, it is proposed to use the term *"thermal bottleneck"* for that location in a cable route that really limits the cable's ampacity. A *"thermal bottleneck"* is different from a *"hotspot"*, which is only a location in a cable route with an elevated temperature at a certain time instant.

Example: suppose there is a cable route, partly installed in soil with bad thermal properties and crossing a hot pipe in soil with very good thermal properties. With low loading, the hot pipe will be a hotspot in the cable route, but it will not per definition be the thermal bottleneck. The thermal bottleneck in this situation may very well be the situation with the soil with bad thermal properties, which was not the earlier defined hotspot.

3. APPLICATION OF DYNAMIC RATING

Performing dynamic rating techniques on power cables has many forms and related benefits. In this paragraph a number of application possibilities that have already been applied in practice will be demonstrated and secondly, economic drivers for introducing dynamic rating techniques are mentioned.

3.1. Technical possibilities

Dynamic rating calculations can be performed for all power cables as long as the current flowing through the cables can be monitored or estimated. From gained experience, three important areas of application can be identified: