STUDY OF THE DYNAMIC RATING OF A 138KV XLPE CABLE SYSTEM BY OPTICAL FIBER MONITORING

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ABSTRACT

This paper reports the result of a feasibility study conducted to install a dynamic rating system on an existing 138kV XLPE cable in pipe system. Two alternatives were investigated. The first alternative evaluates the use of temperature sensing optic fibers previously installed in the steel pipe along with the three power cables. The second alternative evaluates the use of spare fibers of an optical fiber cable installed in an adjacent duct. The optical fiber cable is used for communication / protection system in the proximity of the power cable line. The temperature difference and time delay of the temperature rise caused by the heat from the power cable and seen on the communication duct was evaluated by calculation and confirmed by measurement.

KEYWORDS

Dynamic cable rating, dynamic rating, temperature monitoring, DTS

INTRODUCTION

It is becoming common practice to install a distributed temperature sensing (DTS) system with new underground cables for the purpose of asset management of the transmission line, especially to maximizing the transfer capability of EHV bulk power transmission lines. New transmission lines tend to be designed for higher transmission capacities using large cross-section cable conductors and controlled thermal backfills. In general, the newer the transmission line, the lower the probability of an overloaded operating condition. To take advantage of this potential margin, it is worth considering the use of dynamic rating systems with sophisticated modeling software in combination with installed DTS equipment to determine the available rating capacity. The dynamic rating system can also monitor the cable conductor temperature and predict overload capacity in real time.

It is also desirable to assess the thermal condition of existing underground cables which do not have DTS monitoring systems. The assessments will identify potential hot spots which, once relieved, can result in postponement of system reinforcement. To evaluate the possibility of using existing dynamic rating systems, the author has evaluated retrofitting a dynamic cable rating system to the existing 138kV XLPE cable using the optic fiber cable in the adjacent communications duct.

MEASUREMENT METHODOLOGY

Outline of the existing 138kV XLPE cable

The study object is an existing approximately 10 km long 138kV XLPE cable system consisting of three single core cables installed in one steel pipe and with an adjacent duct for communication cable in a common trench as shown in Fig. 1. A GI optic fibre sensor cable originally designated for DTS measurement was previously installed with the three power cables but is available only for a short section in the middle of the route. Although the GI optical fibre sensor cable installed with the power cables is limited, the communication cable in the adjacent communications duct is continuous from the end to end in the substations. In order to measure the temperature profile of the entire route, it is more desirable to utilize the spare optic fibre core in the communications duct rather than the GI optic fibre core in the steel pipe.

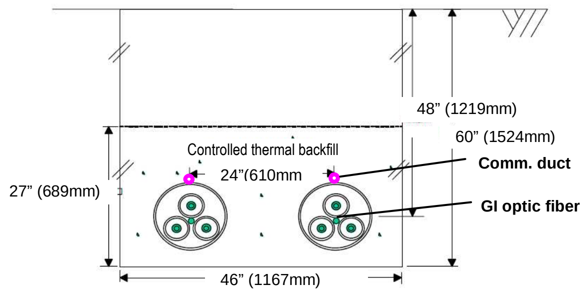

Fig. 1: Typical cross-section of trench

Trial DTS measurement

To demonstrate the feasibly of the temperature measurement of the power cable system from the communication duct, the following trial measurements were conducted.

- First, to simulate using the fiber-optic communication cable, non-metallic optical cable was temporarily installed in the interstices of the communication cable duct (3” PVC) for a length of 50ft from the fiber optic cable pit adjacent to the cable manhole shown in Fig. 2.
- Second, to obtain the reference temperature at the same 50ft apart from the manhole, the optical fiber temperature in the steel pipe was also measured at the same time.
- To confirm the accuracy of the thermal model and the equivalent thermal resistance between communication duct and the power cables, it was necessary to compare both temperatures for an extended time so that the temperature variation in a transient condition or daily cyclic load could be evaluated.
- The transient thermal equivalent circuit model is more complicated than the steady-state model but its principle was introduced in IEC standards [1][2] and the calculation algorithms were established for Dynamic Cable Rating System of previous underground cable projects[3].
- Two sets of DTS systems were installed in the cable manhole and the communication cable pit. Fig. 3.