INSULATION DIAGNOSIS OF HIGH VOLTAGE POWER CABLES

Edward GULSKI, Delft University of Technology, (The Netherlands), e.gulski@tudelft.nl
Johan J SMIT, Delft University of Technology, (The Netherlands), j.j.smit@tudelft.nl
Piotr CICHECKI, Delft University of Technology, (The Netherlands), p.cichecki@tudelft.nl
Frank de VRIES, NUON Tecno, (The Netherlands), frank.de.vries@nuon.com
Paul P. SEITZ, Seitz Instruments AG, (Switzerland), pps@seitz-instruments.ch
Ben QUAK, Seitz Instruments AG, (Switzerland), bq@seitz-instruments.ch
Frank PETZOLD, SebaKMT, (Germany), petzold.f@sebadyn.de

ABSTRACT

In this contribution based on field application of advanced diagnostics a systematic approach for condition assessment of high voltage (HV) power cables is discussed. Based on the assumption that there is not one dominant failure process in HV cable networks in addition to partial discharges also dielectric diagnosis has be included to determine the actual condition of service aged cable insulation systems.

KEYWORDS

HV power cables, advanced diagnosis, condition assessment

INTRODUCTION

Similar to other HV components e.g. power transformers, circuit breakers and overhead lines the average service age of transmission power cable networks is between 30-45 years [1]. Moreover, no or limited knowledge exists about such future performances as:

- insulation degradation processes,
- operation reliability,
- maintenance /replacement expectations.

The transmission power cable networks (HV cable systems) are strategic assets and in contrast to medium voltage (MV) the HV networks are very reliable. In particular, failures in the HV network are not occurring as often as a result of the relative small number of components and the historical good quality and proper maintenance in the past of the network. Also, due to the high redundancy (ring networks, “N-1” criterion) and the possibility of remote switching actions from operation centers, the outage probability and time are relatively low [2].

It is known that the liberalization of the energy markets, the increase of power demand and higher flexibility towards high voltage grids, lead to a more severe exploitation of HV cable systems in the future. As a result, a system failure may lead in addition to emergency repair costs also to a loss of income or to claims. According to [3] repair costs of a failure in a HV cable link can be estimated around 500 €/kV. This means that the repair of a failure in a 150 kV link costs around 75 k€. In addition also costs of not delivered energy have to be taken in to account and these additional costs, depending on claims and penalties as contracted can be much higher.

Thus, in coming years more and more strategic decisions have to be taken about maintenance or replacement of the oldest or cables circuits [3,4], figure 1. Normally, such

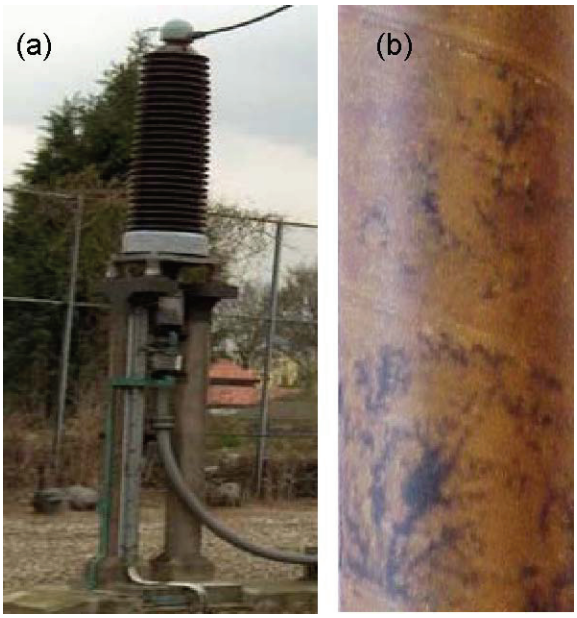

Figure 1: Insulation degradation of service aged HV power cables:
(a) example of external gas pressurized 150kV service aged power cable,
(b) example of insulation degradation by treeing activity through the different layers of impregnated paper insulation.

strategic decisions belong to the responsibilities of asset management (AM), [7]. In particular, based on information about the present and future asset performances e.g. technical condition and the knowledge of degradation processes, decisions about maintenance and replacement can be prepared. However, at present setting up such AM strategies may face three difficulties:

a) due to very low number of failures no statistical predictions are possible [5],
b) degradation processes of HV cables are more complex and the systematic knowledge about the actual aging needs further investigations and field verifications as shown in [3], (figure 2),
c) with regard to HV power cables no fixed diagnostics are available for on-site condition assessment [4,6,12,13], (figure 3).

It follows that assessment of actual condition is getting more important [8,10]. Actual knowledge of the condition of HV cable systems may support the network managers

- to evaluate overall condition of the power network condition,