DEVELOPMENT OF A SIMPLE METHOD FOR CONDITION ASSESSMENT OF OIL FILLED XLPE TERMINATIONS

Knut Brede **LILAND**, Sverre **HVIDSTEN**, SINTEF Energy Research, Electric Power Technology, Trondheim, Norway, Knut.B.Liland@sintef.no
Geir **BIRKENES**, Frank **MAUSETH**, Department of Electric Power Engineering, NTNU, Trondheim Norway, frank.mauseth@ntnu.no
Geir Atle **Ward**, Eilert **BJERKA,** Nortroll AS, Levanger, Norway gward@nortroll.no

ABSTRACT

An on-site/off-line prototype method measuring distributed water content inside oil filled high voltage cable terminations was developed. The method consists of: 1) Measurement rod with relative humidity, temperature and conductivity sensors, 2) Database for three oils converting relative humidity and temperature to absolute humidity, 3) Wireless unit for data transfer to a computer, 4) Procedure for doing measurements. The method proved to be a powerful tool estimating the humidity condition.

More fundamental laboratory studies with provoked water leakage into the termination were also performed showing that partial discharges monitoring is not sufficient to detect water intrusion.

KEYWORDS

Relative humidity sensors, absolute humidity, water content, free water detection, silicone oil, hydrocarbon oil, wireless offline measurement rod, oil filled cable terminations, preventing explosions, failure detection

INTRODUCTION

Norway has 6000-7000 oil-filled high voltage cable terminations in the transmission network. For these installations it has been registered some severe failures the last 10 years with potential for personnel damage due to explosions and fire. Investigations have given information about possible causes. One of the main reasons is water intrusion into the insulation fluid (silicone fluid, hydrocarbon oil). This could be caused by bad installation work or indirectly thermal cycling due to heating by the sun dragging water (from rain) into the installation via deteriorated old gaskets and o-rings. Leaking water will move in the insulation fluid downward along the cable in the termination leading to electric field enhancement around the water droplets. Service breakdowns due to water ingress have also been registered in other European countries.

The installed XLPE HV terminations in Norway are mainly from two manufactures. Recommendations for maintenance [1] have been developed with the purpose to detect water intrusion and to recommend actions in service. The procedures are necessary but complicated, time consuming and can in worse case lead to a requisite demounting of the installation two times. With the suggested improved method described in the following this will be significantly simplified. The oil sampling will also be done at the same locations each time.

DESCRIPTION OF PROTOTYPE INSTRUMENTATION FOR THE FIELD MEASUREMENTS

The prototype measurement unit is developed as a demountable metal rod with a contact for electrical wiring and communication in the junction point. A conductivity sensor with a mechanical protection to avoid cable cone damage during insertion was positioned in the end of the rod to detect liquid water in the bottom of the termination. Two combined RH and temperature (RH/T) sensors were also positioned to detect the oil condition; one to measure just above the cone and another to monitor the upper part of the termination. The metal rod was designed in such a manner that the sensors easily could get in contact with the oil (perforated metal shell) during the measurements. The oil level in the termination can also be detected with this rod.

The sensors used in this equipment were qualified and chosen according to their properties at different conditions: response time, wet to dry transitions, dry to wet transitions and size [2]. In order to know the absolute humidity the solubility curves for these oils are used giving the relation between the relative humidity and the temperature [3]. The conductivity sensor exploit the difference in conductivity between water and oil and uses the potential difference

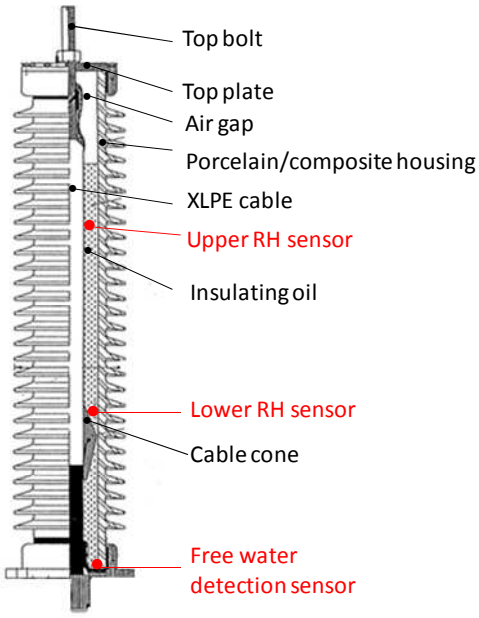

Figure 1: Position of different sensors (●) on the fully inserted off-line measurement rod in the oil-filled housing.