

INTERNET UPDATE

Cable Condition Monitoring

By Ken Barber and Graeme Barnewall, Olex

Abstract of the third article in a three-part series on underground cables
for *Australian Power Transmission & Distribution Cables* magazine

Summary

Industry demand is escalating for a better understanding of the condition of installed underground cables using real-time, continuous condition monitoring.

Introduction

Power cable users are increasingly seeking products and systems which can determine what changes are occurring in the cable environment or to the properties of the cable insulation and accessories. Condition monitoring of power cables is becoming a reality with the introduction of new methods of recognising and measuring the various parameters that effect cable performance.

However, the technology to measure these various parameters is only one part of the puzzle - to understand what the results mean can still be the most difficult task of all. Within the cable engineering sector, understanding has grown enormously in recent years about the influence and importance of issues such as soil thermal resistivity, soil temperatures and mutual heating from adjacent circuits. However, much work is still needed to allow system operators to confidently make (sometimes critical) decisions regarding operational limits for cables in service.

Modes of cable failure

Power cables fail for a number of reasons, the most obvious, and readily detectable cause being severe external damage. More subtle effects such as overheating, moisture ingress, poor accessory installation, cable or accessory defects, can also lead to degradation of electrical properties over time, and eventually lead to cable failure. It is these effects that need to be understood in order to make a judgement on the condition or "health" of a cable system. Such defects can often cause a detectable electrical phenomenon known as partial discharge (PD).

Manufacturers of XLPE cables take great care during manufacture to ensure no sites for PD activity exist, and during routine testing, all cables are energised well beyond their working voltage during which PD is monitored and no cables are released if there is any possibility of PD.

In the field, these cables must be fitted with accessories for jointing or termination, and unless the design and workmanship in fitting these accessories is effective for the electrical stress levels involved, PD can occur at the interface between cable and accessory.

As cables age the insulation material may also lose some physical properties (this is especially so for paper insulated oil impregnated cables). Overheating accelerates the ageing process and in extreme cases the insulation can become so fragile that a bump, or sudden increase in thermal expansion (e.g. an emergency load being applied), could initiate cracking of papers or material deterioration which can be a site for the initiation of PD.

XLPE can also suffer from the phenomenon of water treeing, where under the influence of electrical stress and moisture, "trees" (which are microscopic void channels) can propagate slowly through the insulation, causing increasing levels of PD and leading to eventual electrical breakdown. It is consequently extremely important that highly stressed XLPE insulation (such as in EHV cables) have an effective moisture barrier provided for their entire lifetime.

New circuits

DRAFT COPY

Client: Olex
Project: Internet Update – APT&D Article Part 2
Date: 28 April 2003
Draft: 1
Copywriter: Noelani Bower 0417 761 747

INTERNET UPDATE Olex

Including an optical fibre within a cable or directly attached to the installed cable is becoming an essential requirement for any new cable system. This allows monitoring of the cable temperature over its entire length via Distributed Temperature Sensing (DTS). The asset manager of a cable system in 10-20 years time will be highly critical of the engineer who today installs cable which does not include the means of quickly and easily monitoring the performance of that investment.

Olex's experience is that while the inclusion of optical fibres has been available for some time, it is just in the past two or three years that most key transmission or sub-transmission circuits in Australia and New Zealand are now being provided with optical fibres. This trend is continuing and expanding to include distribution circuits and substation cabling. While many within the cable sector expected that users would quickly take up the option of obtaining their own DTS units, this trend is only being adopted by major utilities and networks who can afford to have suitably trained personnel. Many other companies are contracting companies like Olex to conduct regular checks so they can take advantage of the cable manufacturer's expertise in analysing the results. This trend is also expected to continue until more user-friendly software is developed to interpret the massive amount of data produced by DTS, load current and other monitoring devices.

In regard to EHV, there is a growing trend to consider the inclusion of PD detectors in accessories, which can be used for detecting PD at installation, and also later in service.

Systems for continuous moisture detection within cables and monitoring of sheath fault protective devices used on cross-bonded cable systems are also being developed. Damage to a cable sheath is the early warning system that cable damage may have occurred, so regular sheath testing is a minimum requirement.

Existing circuits

Perhaps the most pressing needs for most utility engineers is the assessment of existing circuits. The retrofitting of optical fibres for DTS and associated monitoring is generally not practical over the complete length of an existing circuit. The solution is to install optical fibre over a key hot spot area or provide specific temperature and soil thermal analysis probes at selected key points to confirm empirical calculations and ensure the circuit is operated with design limits.

It is likely that PD measurement will increasingly be adopted to assess system reliability on older circuits. There is considerable interest in adopting more sensitive real-time PD monitoring at system voltage, but at present this is probably limited to Paper Insulated Cable systems, where it is possible to detect potential failures in accessories due to such factors as moisture ingress.

For XLPE cable, PD testing with test voltages at near-to-normal power frequency, but at higher-than-service voltage, is much more likely to yield the greatest benefit in detection of potential weaknesses in the system. Cables have to be taken out of service to carry out such testing but only with these higher test voltage can PD be detected and action taken to prevent system failure.

Conclusion

The cable sector is entering a new era in which there will be even more significant advances in cable condition monitoring which will improve overall reliability of electricity supply and reduce investment and maintenance costs.

Olex will have an exhibition stand at the next TechCon Conference from 8-9 May 2003, in Sydney, Australia. Olex engineers will be available to discuss all aspects of cable performance.

Copies of this article in its entirety and more information is available from Olex Engineering and International Sales on +61 3 9281 4444 or email Ken Barber at kbarber@olex.com.au or Graeme Barnewall at gbarnewall@olex.com.au

DRAFT COPY

Client: Olex
Project: Internet Update – APT&D Article Part 2
Date: 28 April 2003
Draft: 1
Copywriter: Noelani Bower 0417 761 747