Monitoring and lifetime prediction of PVC cables:

Methodology by multiscale and multidisciplinary approach

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ABSTRACT

In a nuclear power plant unit, electric cables represent about 1500 km. Currently, most of the French power plants in operation mainly have qualified electric cables on PVC. All these PVC cables are considered as "sensitive" because of their presence in large number in nuclear units and the high cost that the replacement would represent (cost including heavy maintenance and a long shutdown period).

In this context, EDF R&D manage research projects on PVC cables with the aim to improve the lifetime prediction accuracy of cables, to manage obsolescence and to develop non-destructive exams to follow their aging on site.

To date, the end-life criterion unanimously adopted for cables is a mechanical one setting on a nominal value of the elongation at break (ε_r = 50%). To our mind, only tensile tests enables the measurement of the elongation at break of a material in a direct way. This technique has the double disadvantage of being destructive and to require sampling on nuclear material which is always a costly and heavy procedure. Thus, it is unbelievable to use this technique for monitoring PVC cables installed all over the French nuclear units.

Previous studies [1-2] conducted on PVC degradation give the demonstration that embrittlement of a plasticized PVC sheath is closely related to its loss of plasticizers. From this observation, EDF R&D decided:

- first, to simulate the physical loss of PVC plasticizers at different temperatures using the Fick laws;
- and then to access the elongation at break either by a simple multiscale relation between ε_r and plasticizer content or by the reproduction of the PVC tensile test curve using laws of behaviour.

This methodology, currently validated for thin PVC films, enable to access the elongation at break value after a local measurement of plasticizer content thanks to a micro-sample analysis or simply by a non-destructive technique (for example infrared spectroscopy). In addition, it makes the lifetime prediction possible in different thermal conditions.

The next step of development, planned for the next few months, consists in extending the physical loss simulation to thick materials by taking into account plasticizers diffusion. In the short term, this work will give us the opportunity to preventively anticipate PVC cables embrittlement. In a longer term, this methodology could also be applied on other equipment like PVC geomembranes.

REFERENCES

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