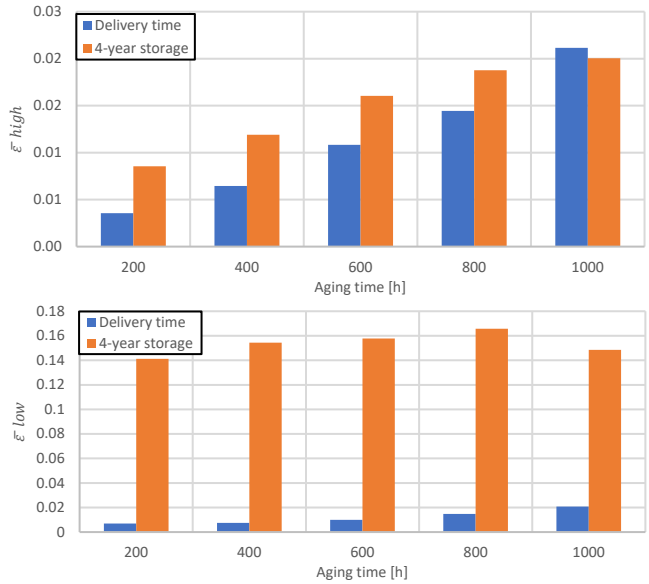

Figure 4. High (a) and low (b) frequency equivalent imaginary permittivity trend as a function of aging time for the two tests periods

5. CONCLUSIONS

This paper deals with electrical and mechanical properties of irradiated NPP cables which show significant changes after few years of uncontrolled environment conditions due to post-irradiation effects.

Experimental tests show good correlation between dielectric and mechanical response.

Splitting dielectric spectrum into two parts we could single out different degradation effects such as oxidation, crosslinking and additives consumptions. In particular, we introduced a new factor, called *equivalent permittivity*, which turned out to be a good marker to quantify aging degradation of polymers, highlighting possible post irradiation effects.

Above all, during this research we were able to conclude that once a polymer is irradiated with high dose rates, like e.g. due to a nuclear accident, insulation condition changes even after few years from the event. Indeed, it has been shown that degradation evolves over time even when the radiation or other stress sources are turned off. Therefore, diagnostic measurements must be repeated and monitored even years after.

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REFERENCES

[1] International Atomic Energy Agency. (2004). Management of life cycle and ageing at nuclear power plants - Improved I&C maintenance.

[2] International Atomic Energy Agency. (2012). Assessing and managing cable aging in nuclear power plants.

[3] Laboratories S. (2005). Nuclear energy plant optimization (NEPO) - Final report on aging and condition monitoring of low-voltage cable materials.

[4] Verardi L. (2014). Aging of nuclear power plant cables: in search of non-destructive diagnostic quantities. PhD Thesis, University of Bologna.

[5] Verardi L, Fabiani D, Montanari GC. (2014). Correlation of electrical and mechanical properties in accelerated aging of LV nuclear power plant cables. IEEE ICHVE Poznan, Poland.

[6] Linde E, Verardi L, Fabiani D, Gedde UW. (2015). Dielectric spectroscopy as a condition monitoring technique for cable insulation based on crosslinked polyethylene. Polymer Testing.

[7] Wise J, Gillen KT, Clough RL. (1997). Quantitative model for the time development of diffusion-limited oxidation profiles. Polymer 38(8): 1929-1944.

[8] Suljovrujic E. (2013). Post-irradiation effects in polyethylenes irradiated under various atmospheres, Radiation Physics and Chemistry.

[9] IEC/IEEE 62582-3. (2012). Nuclear power plants – Instrumentation and control important to safety - Electrical equipment condition monitoring methods Part 3: Elongation at break.

[10] Nakamura S, Murabayashi F, Iida K, Sawa G, Ieda M. (1987). Degradation of dielectric properties of polyethylene by combined -irradiation and thermal stresses. IEEE Transactions on Electrical Insulation 22(6): 715-720.

[11] Fu M, Chen G, Dissado LA, Fothergill JC, Zou C. (2007). The effect of gamma irradiation on space charge behaviour and dielectric spectroscopy of low-density polyethylene. IEEE Conference Winchester, UK.