CONDITION MONITORING, THERMAL AND RADIATION DEGRADATION OF POLYMERS INSIDE NPP CONTAINMENTS - COMRADE

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Konsta Sipilä[1], Harri Joki[1], Tiina Lavonen[1], Antti Paajanen[1], Sami Penttilä[1], Jukka Vaari[1], Marcus Granlund[2], Anna Bondeson[2], Anna Jansson[2], Louise Wogelred[2]

[1]VTT Technical Research Centre of Finland Ltd

[2]RISE Research Institutes of Sweden

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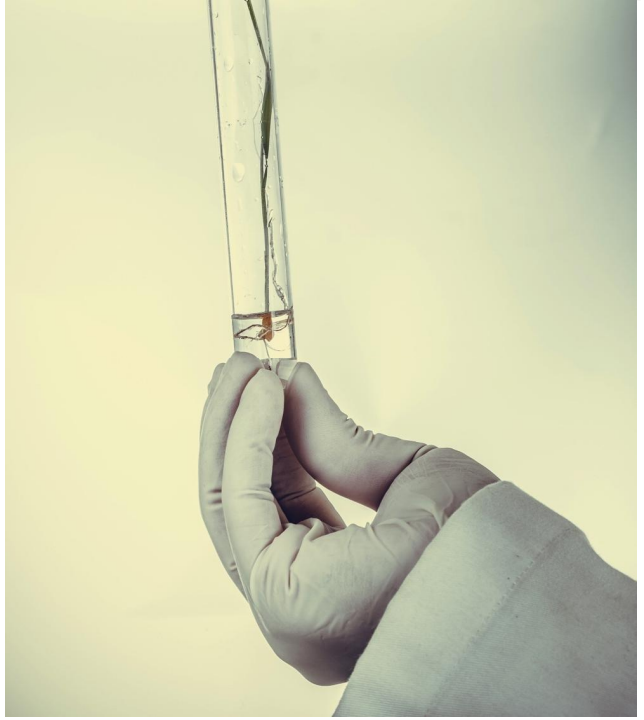
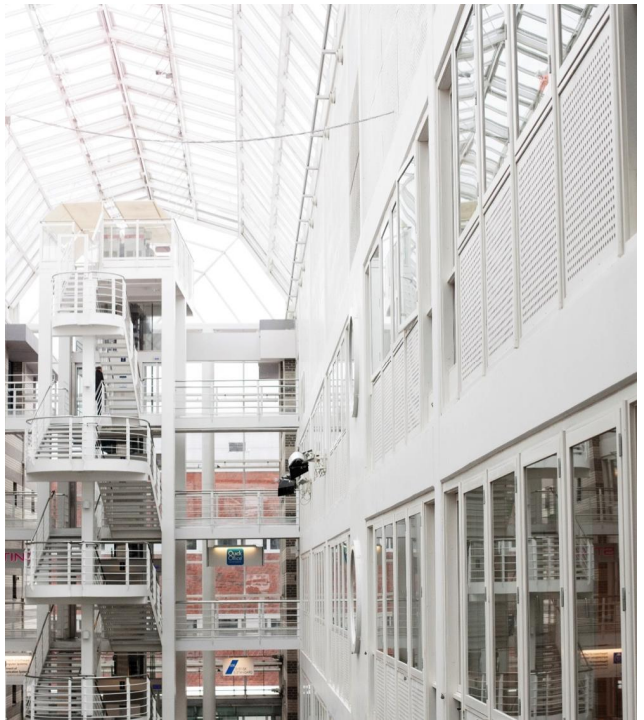
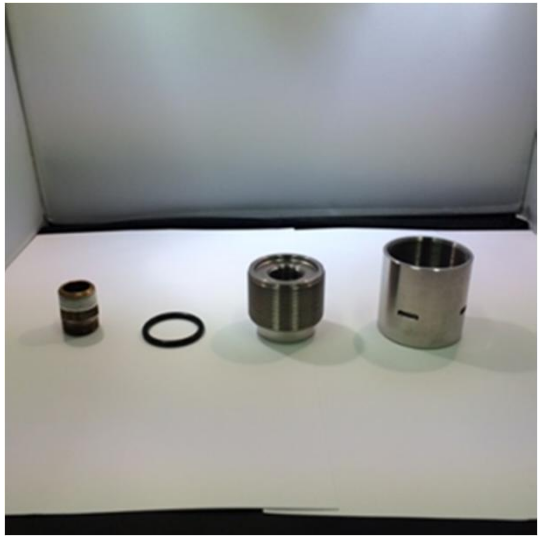
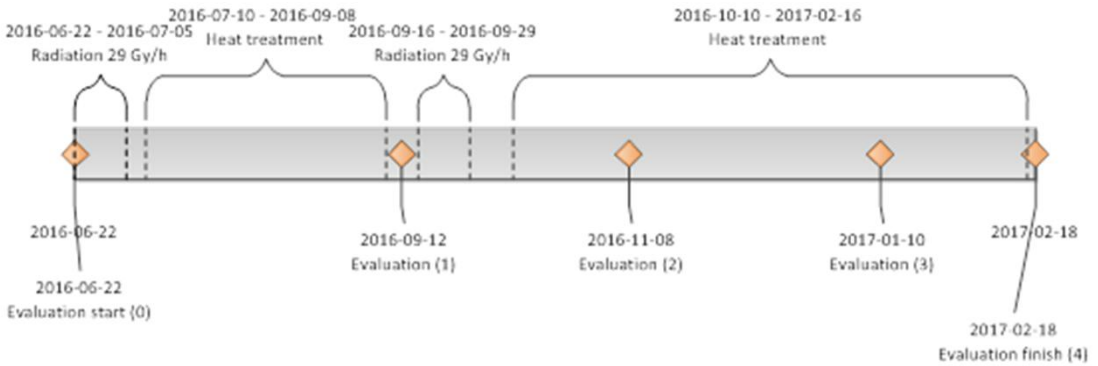




WP1 Development of condition monitoring methods for polymeric components including low dose rate radiation exposure

- Ageing of peroxide cured EPDM
  - O-rings cord diameter 3.53 mm, 25 pcs
  - Sheets for dumbells 2 mm thick 50 pcs
- Ageing in the sequence shown in the time line
  - 3 different temperatures (90, 120, 140 °C)
  - Irradiation 29 Gy/h, total dose 14 – 18 kGy
- Functional test in test rig shown to the right in both mounted and dismounted state. Leak indicators marked in red
- Material properties tested at ecah evaluation
  - DSC OITe, Hardness, Comp. Set, Tensile, Tightness

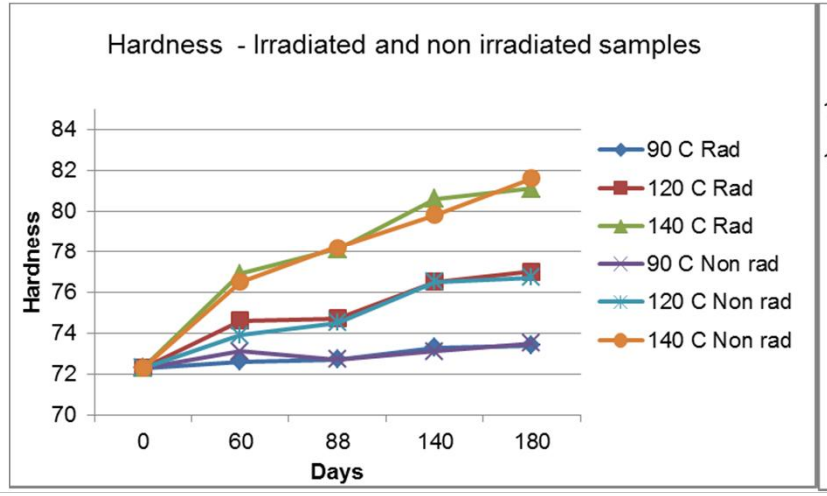


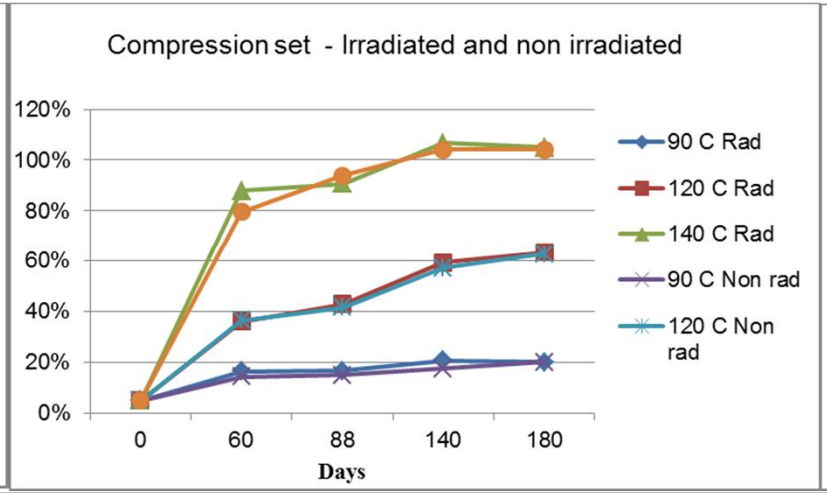


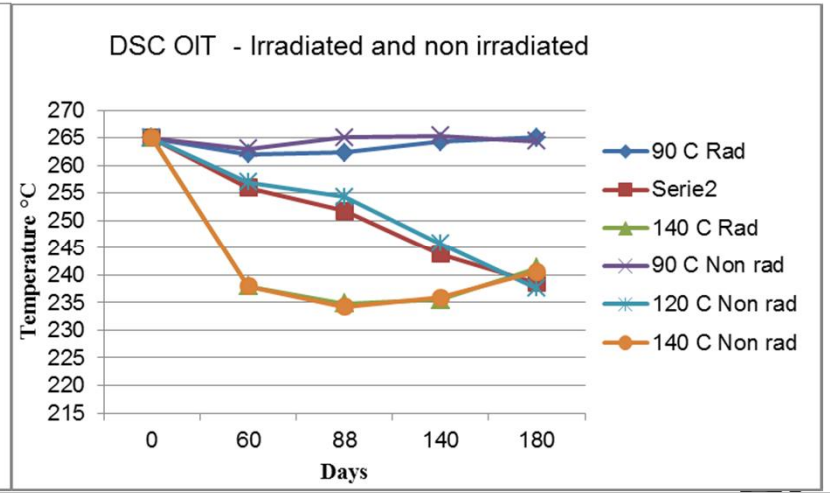
WP1 Result

- Small difference in material properties between irradiation and non irradiation can be seen.
- Furthermore the DSC OITe shows a similar change for both 120 °C and 140°C for evaluation 5 even though compression set shows a large difference still.
- Correlation of End of life criteria in the table to the right.

Property	End of life	Initial value
Compression set	105%	4,9%
Hardness	80	72,3
Elongation at break	50%	182%
Tensile strength	7,5 MPa	12,8 MPa
DSC – OITe	235,9°C	265°C







WP2 Barsebäck pre-study and WP3 Polymer ageing mechanisms and effects inside NPP containments - results

WP2 results from interviews

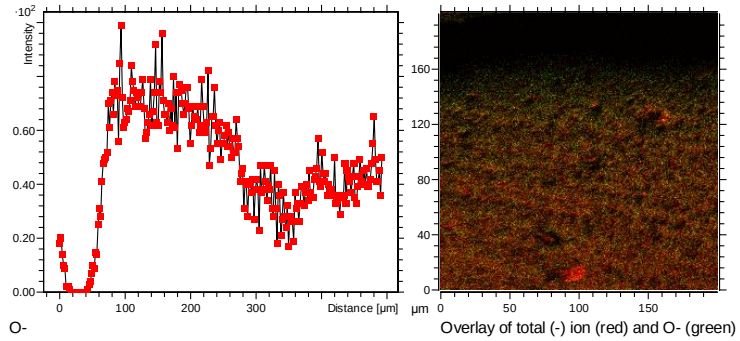
- Two material experts related to Barsebäck polymer components were interviewed in order to clarify whether the used components could be taken out from the plant for ageing studies
- The polymer components available for ageing study which service conditions are well documented are few in numbers
- Radiological clearances and the related precautions to working with decontaminated materials would yield in complicated and costly material acquisition
- More feasible way to obtain materials aged in real conditions would be acquiring materials from running plants during annual take outs.

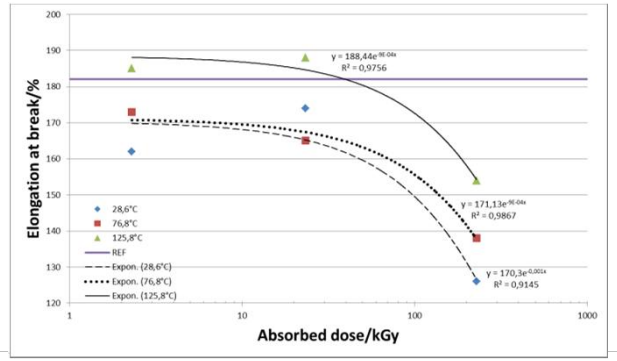
WP3 goals

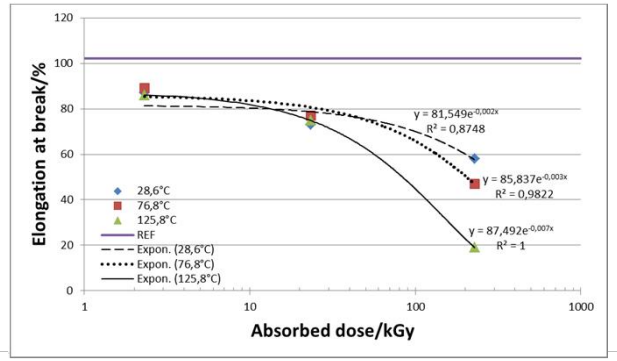
- The application of computational modelling methods in polymer ageing modelling, is it possible to create an ageing model that predicts the macroscale ageing based on the atomic scale reactions?
- During a DBA, is the thermal or radiation induced ageing more severe to a polymer and is there some kind of synergistic effects?
- What kind of techniques could be used in oxidation gradient studies and how the surface oxidation relates to the mechanical properties of polymers?
- How severe is the dose rate effect during normal service life time and what kind of methods exist that could be used predicting it without resorting to very low dose rate irradiations?

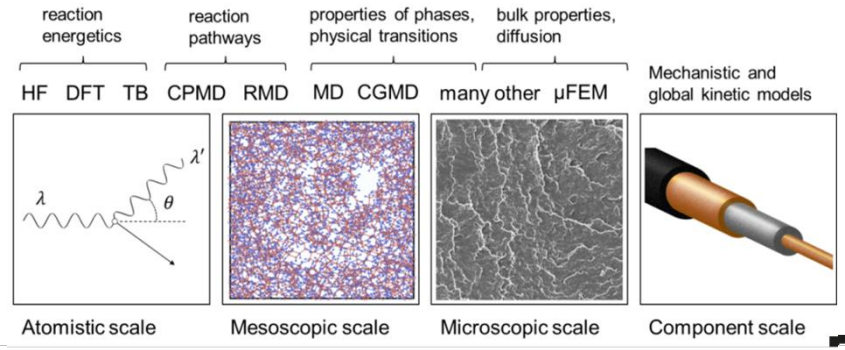
WP3 Polymer ageing mechanisms and effects inside NPP containments

- Polymer ageing occurs at different size and time scales. Currently a multi-scale material model that takes account all size and time scales does not exist. The current ageing models are semi-empirical and have limited applicability
- From experimental work conducted it was noted that during a DBA, temperature can be either beneficial or accelerate degradation, depending on the polymer type. The synergistic effects of radiation and heat were experimentally studied with EPDM and CSM. As a result it was noted that increasing temperature can either hinder or accelerate degradation
- From oxidation profile measurements it was noted that ToF SIMS seems to be a promising method to obtaining from the three techniques tested (FTIR and DSC being others). ToF SIMS was sensitive to detect oxygen content on the sample surfaces and also sensitive towards surface roughness so careful sample preparation is required
- For dose rate effect evaluation, three different semi-empirical models (power law model, superposition model and DED model) were identified which could be applied for this purpose. However, they require quite large amount of experimental data in different environments and the use of already existing data is material dependent

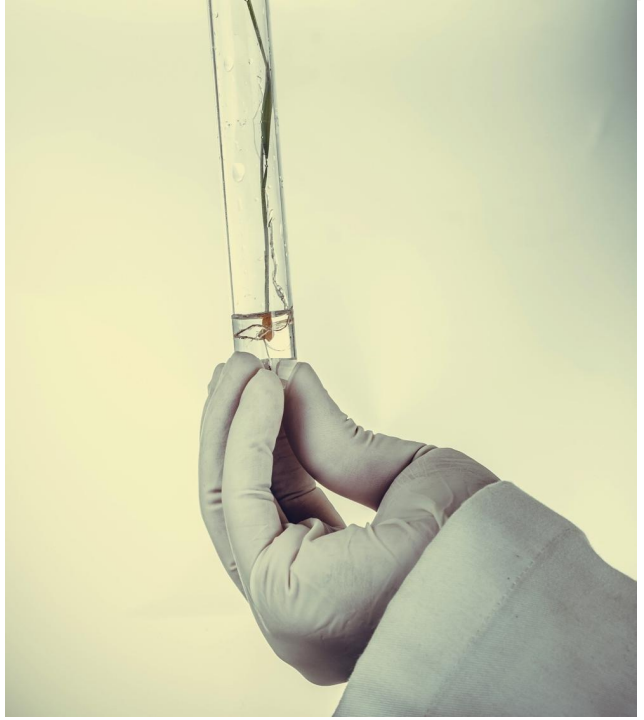


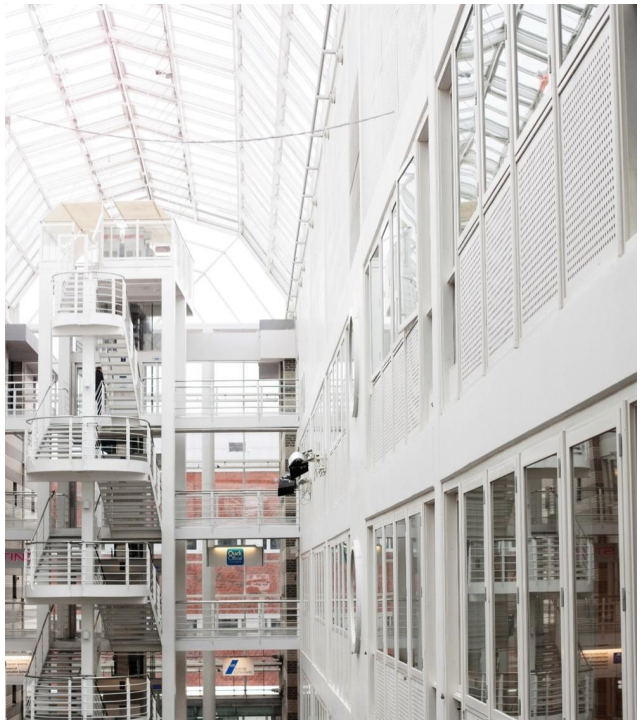






THANK YOU!





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