WP2 COMRADE
- Identification of available polymers and their data from Barsebäck

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SP Report 2016-12-07:
P601138-02

Background

Polymer ageing studies involve usually accelerated ageing procedures where the ageing phenomenon is speeded up by using more aggressive environmental parameters, such as high temperature and high dose rate. The accelerated ageing procedures are generally simplifications of the real ageing environments and they presume that there is one dominant ageing mechanism that governs the molecular and microstructural level changes in the polymer matrix. When sufficient amount of changes occur in these structures, their yield is ultimately observed in the macroscopic material properties. Thus it is likely that some environmental factors and their effects to polymer ageing occurring during normal service life are neglected in the accelerated ageing treatments. However, acquiring aged components from real service conditions and studying their material properties could provide more detailed information on degradation mechanisms and kinetics occurring in real service conditions. This information would be valuable when accelerated ageing treatments that aim to simulate the real ageing conditions are validated. Within this pre-study, polymer materials available for research use from nuclear power plants (NPP) under decommissioning (e.g. Barsebäck) and materials taken from outages in running Nordic NPPs are mapped. The available materials can be used to verify the O-ring condition monitoring method developed in COMRADE-project (WP1) and degradation processes studied in (WP3). Also obtaining EPDM components from sealant applications provides a possibility to study how the ingredients mixed in the polymer have effect on their ageing behaviour.

Goal of the study

The goal of this study is to identify polymers from Barsebäck NPP that could be available for research purposes. Also polymer service conditions are under interest as well as procedures related to moving polymer components out from the plant.

Methods

Two contacts were interviewed related to Barsebäck polymer materials. Lars-Uno Berg which is head of business operations at Barsebäck Kraft AB and his colleague Lars Appelgren who was presenting their response.

Results and discussion

Barsebäck Kraft AB (BKAB) is fully owned by Sydkraft Nuclear Power AB and part of the Uniper group. They have about 50 employees most of them work with service operation and a few with business operations. Business operations handles lease premises, sell components and holds training courses and this division of Barsebäck Kraft AB is not financed by the Nuclear Waste Fund, but is self-sufficient. This means they need funding for further investigations because they are not able to work in kind.

Barsebäck plant was contacted to investigate the possibilities for retrieving used polymeric materials from the closed down containments. They did inform that they possibly can provide polymer materials with documentation. They had selected a plastic impeller and o-rings from a certain small pump inside the reactor containment as suitable candidates. The pump has been serviced yearly so the polymeric materials have not been in service for a very long time. No deeper investigation has been made to identify what polymer types the material consists of. They have not found any candidate joint sealants or cable transit that have been exposed to radiation and if there existed any, they would not be well documented. Barsebäck plant does not have the ability to give radiological clearance in situ so an external authorized regulator must be engaged. Also it should be noted that it is not certain that the equipment that has been in the enclosed premises could be given a radiological clearance at all. If the polymeric material cannot be given radiological clearance the examination must be done in the controlled area. If the investigations will be done in situ the following things must be arranged: admission, training of personnel in handling radioactive materials which would consist of two to three day-course (I), use of dosimeters (II) and the used testing equipment will have to be given radiological clearances afterwards (III). This would increase the cost significantly compared to testing conducted at standard material testing laboratory. Another aspect against using materials from Barsebäck is that after the outtake of the reactors the materials have been stored for many years in different temperatures and atmosphere than the normal service conditions. Because of these difficulties and based on the discussion between project team and industry group, the search of aged (i.e. aged at real service conditions) polymeric materials has been broaden to include the NPPs in service and plants that just have been or soon will be taken out of service.

As the results from Barsebäck interviews indicate, obtaining polymer components from there would be tedious and costly. Also uncertainties related to the history of service conditions would complicate the use of these materials as reference to artificially aged ones. Thus obtaining polymer components from running plants during outtakes seems to be more feasible option. For this purpose a questionnaire is introduced to NPP polymer material experts (via COMRADE industry group) to obtain data on different polymers available to study. The questionnaire is attached to this report as an appendix and it will compile the materials that interesting for industry and the project team, materials available from different Nordic NPPs and their service history. This work will be continued within COMRADE-project during year 2017.

Conclusions

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 and which service conditions are well documented are few in numbers. Also radiological clearances and the related precautions to working with decontaminated materials yield in complicated and costly material acquisition. More feasible way to obtain used materials from properly documented service environments would be acquiring materials from running plants during annual take outs.

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Appendix

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Date 2016-12-07 Reference Page 1 (2)

Questionnaire for mapping polymer components for ageing studies

In the scope for the project "Condition Monitoring, thermal and Radiation Degradation of polymers inside NPP containments" (COMRADE) WP2:"Learn from materials used in plants – A feasibility study " this questionnaire is sent to NPPs and other nuclear entities to gather information about polymer components that these entities are interested in with respect to their ageing behavior and possibilities for obtaining these polymer material for testing. More information at http://www.energiforsk.se/program/polymera-material-i-karnkraft/projekt/wp2/ .

The following materials / components are of primary interest for the COMRADE project team to investigate.

- O-ring of EPDM, Nitrile, Silicone or Viton
- EPDM seals/gaskets
- Joint sealants / sealants
- Cable transits (eg Brattberg cable transit)
- Sealing foam (polyurethane, etc.)
- Cables (Lipalon HHSO-type is previously studied in COMRADE)
- Lubricants and greases
- Paint coatings

The focus is to investigate the components you would otherwise not reach, and preferably those that have been exposed to radiation to some extent.

Is there available documentation of the materials? For example a material specification with product names / manufacturers and material properties such as hardness and original dimensions.

We would like to know what environment they have been exposed to during operation and also the conditions following removal from service. For example, time, pressure, temperature, and ambient gas / air, humidity and water?.

At the back of this document there is a table where the parameters for the chosen components can be compiled. We would like to receive your response no later than December 23rd.

Best regards,

Anna Bondeson
Technical licentiate and project leader of WP2

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Designation of component	Type of component (eg o-ring for pump, gasket for valve)	Polymer type	Time in use (operation)	Operating temperature	Operating Pressure	Operating atmosphere (eg Air, nitrogen, water, humidity)	Approximate dose rate during operation	Storage time after removal	Temperature after removal (approximate)	Pressure after removal (approximate)	Atmosphere (eg Air, nitrogen) after removal	Possible to test outside NPP (clearance)?

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6P01138-02