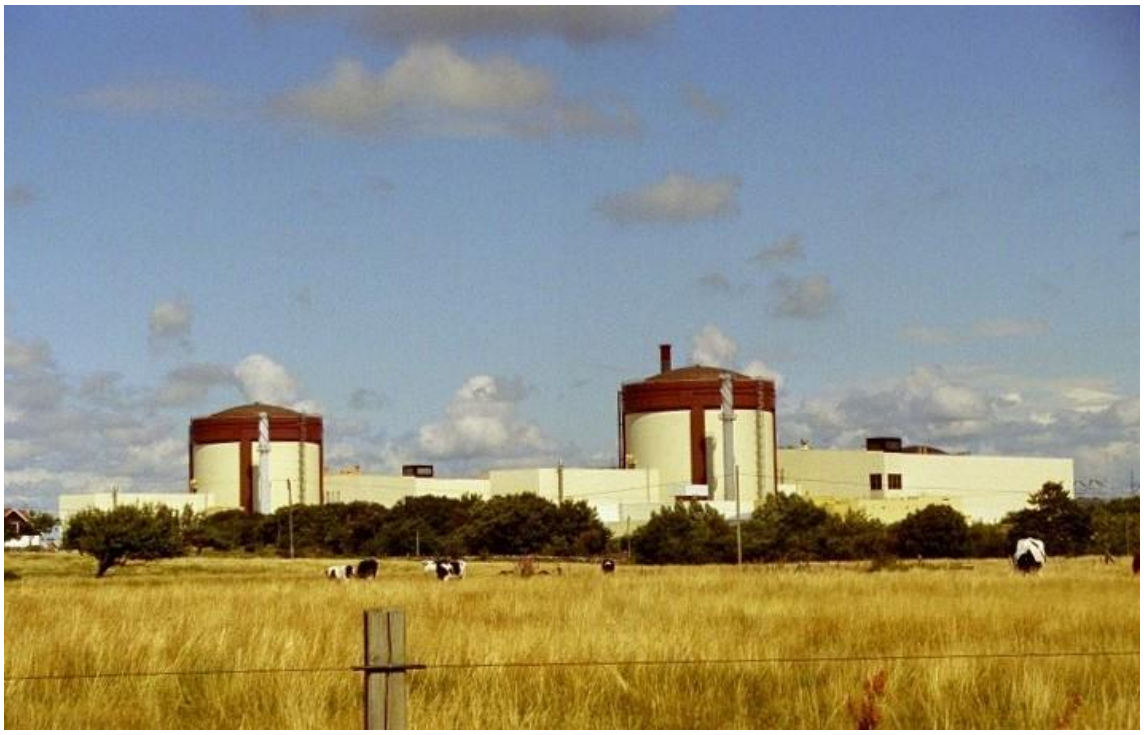
BIOSCIENCE AND MATERIALS
CHEMISTRY AND MATERIALS



WP1 SAMPO Task 1.1
- Lifetime estimation

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RISE Report : 9P03241-01

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Background and aim

This task makes use of the results and analyses from the completed COMRADE project when suggesting new acceptance criteria and safety margins. Results from laboratory aging tests and evaluations have been compared to materials obtained from Nuclear Powerplants (NPPs). Improvements to both test methods and aging environments are required to set acceptance criteria as well as safety margins. Some polymer components are extremely complicated or impossible to change in operating NPPs and thus their endurance during the whole lifetime of a plant is essential. To be able to make reliable lifetime estimations of components, information on material properties on both materials that have been in use at NPPs and artificially aged materials is extremely valuable. The question of residual lifetime assessment of polymer components in service is often raised. Without sufficient material data and service history of the materials, i.e. temperature, radiation dose, oxygen and moisture content in the atmosphere, this is almost impossible to predict. By studying materials from NPPs available from outages and decommissioned plants that have been in service for at least 40 years, we have a unique opportunity to develop material lifetime prediction methods with correlation to materials from real service environment and long-term use.

The aim of this task is to identify critical components and to investigate the possibilities to obtain such components from plants under decommissioning, including material data. For example, decommissioning of Ringhals R2 which will be closed December 31, 2019 means that the chosen components can be obtained in 2020, at the earliest. Then the service history of components will be secured.

It has proven that it is difficult to get clearance of materials used in the NPPs and it is sometimes also difficult to achieve sufficient amounts of materials to perform relevant tests, therefore a full year project including workshops together with the NPPs is planned for this task to be able to discuss what components to choose. One group of materials mentioned in the running project are cables. Moreover, replaced materials from outages will be considered. In COMRADE many samples were too small and not in sufficient amount to be analysed. Therefore, artificially aged materials will be investigated in parallel. This work package will be run in collaboration with micro-calorimetry (MC) tests in order to calculate activation energies and verify the MC technology.

Project plan

The work package task will follow the plan below:

1) Identification of critical components in all plants

2) Possibility to extraction the components from plants

3) Estimating their residual and total lifetime.

4) If possible, order samples made from the same material from the supplier

For year one the plan was to hold workshops with NPPs. Based on these discussions selection of choose material from closed NPPs and/or from outages should be made and find suitable reference materials. Design a test schedule for year 2-4. Reporting for year 1 should include minutes from workshop and test schedule.

Methods

Workshops to be held at the selected NPPs will be the main method for investigation to identify critical and interesting materials. In the first stage focus has been on Ringhals because of their upcoming decommission of two reactors.

Discussion of materials of special interest for the project were held at the SAMPO workshop at Fortum, Espoo in November 27-28th 2019.

Results and discussion

Workshop at Ringhals NPP

Meeting notes Ringhals 2019-10-29

Participants:

Mechanical group
Stjepan Jagunic
Freddie Nylund
Ann-Sofie Sundell

Electrical group
Josef Sumegi
Anders Nygårds
Patrik Rydberg
Mikael Nilsson

Construction group
Johanna Spals
Niklas Johansson

RISE
Anna Bondeson
Martin Bohlén

Anna gave a brief information about the project and the agenda.

General comments on areas where more information or material may be of interest from the closure of Ringhals 2:

- New cables from Nexam
    - There is not much information about the material and long-term properties besides the supplier's certification, consisting of polyolefins.
    - Indenter measurements work poorly for these cables: alternative method?

- PVC cables from the containment used for a long time may be interesting to check, however, most PVC cables are exchanged for Nexan cables relatively recently in R3 and R4.

- Valve membranes
    - replaced relatively often and there are the possibilities to increase intervals
    - there are materials of the same type with several different exchange intervals to test on
        - there are already membranes available which are ready for testing only need a little more data on which temp, moisture, etc. during operation.
    - May be more interesting than o-rings as it is more critical in case there is leakage.
    - Previous tests have been done with accelerated aging on natural rubber membranes this can be used for comparing used membranes. Tensile tests are also made on a membrane used for 12 years, which showed that it was a bit more "aged" than expected.
    - The reinforcement is the weakest part of the membranes, this should be investigated more
        - What kind of reinforcement is sensitive?

- Test of LOCA or other accident simulation on replaced materials, as well as on accelerated aged material.

- Cable penetrations
    - There is a variant consisting of some kind of joint sealant (goo) that could be sensitive to a blast, adhesion might be tested on this.
    - Brattbergare is already under investigation

- Joint mass between concrete elements (e.g. between ceiling and wall)
    - Much of the material has been changed recently, and this has already been investigated.

New rig to measure compression setting and leak tests

- Radial assembly of the O-ring is preferable because it is exposed to more strain and is more common.
- The Mechanical department will send blueprints with examples.

Henrik Toss – Online monitoring

- Antenna sensors
    - Dielectric properties change with aging
    - Possibly, GSM networks (less radiation compared to conventional mobile network) in containment can be used, ask about what power limit?
    - One problem is that reference values are missing
    - RFID tag may be suitable for membranes, the tag or wiring might stick out of the membrane
- Change in electric length (LIRA)
    - Already used on Ringhals to find hotspots
    - Long cable length required (about 20 m)
    - Usually runs at 80 - 100 MHz, a change in frequency could potentially reduce the requirement of cable length

Selected materials for testing

EPDM o-rings were selected as a special point for interest, as these materials are easy to obtain and may be compared to the tested materials for verifying results in COMRADE WP1 and SAMPO WP1 T3.

Another interesting group of components are membranes. Ringhals has collected membranes from earlier revisions and the collection contains several membranes of same type and of different time in use.

More suggestions of material will be obtained from Ringhals in December and the other NPPs after workshops held in the beginning of next year.

Conclusions

A Workshop was held at Ringhals NPP and discussions was held over which polymeric materials can be critical and /or interesting to obtain from the closing down reactors or at the revisions. The suggestions of materials and their properties will be reported by the Ringhals NPP material experts in December.

Two more workshops, at Forsmark NPP and OKG NPP, will be scheduled for the beginning of 2020 and contacts with Finnish NPPs will be taken. After that the final selection of suitable materials will be made.

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