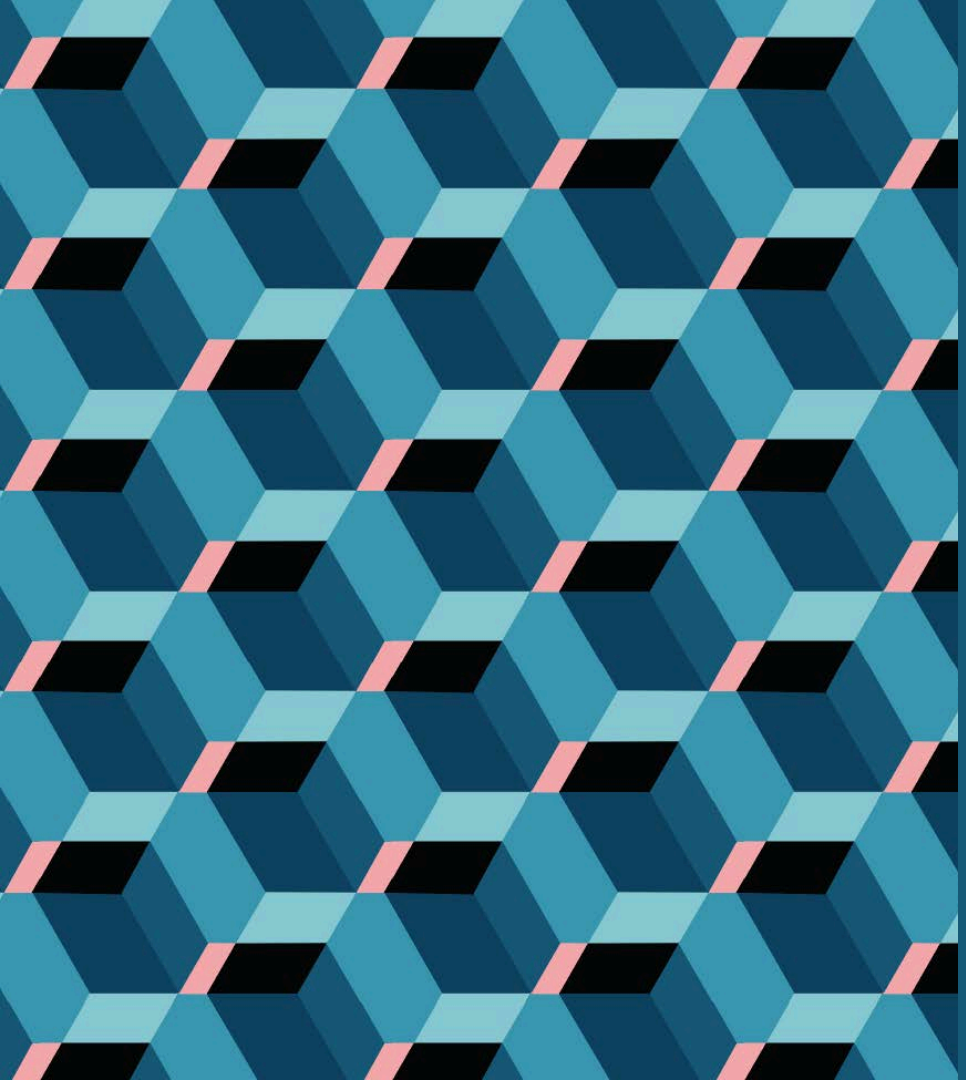

SAMPO - Safety criteria and improved ageing management research for polymer components exposed to thermal-radiative environments

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SAMPO as part of SAFIR 2019-2022

- Project is divided into three work packages and WPs are further divided into tasks
  - WP1 - Acceptance criterion and safety margin assessment
    - T1.1 - Improved estimation for lifetimes of critical polymer components (RISE)
    - T1.2 - Sensitivity of polymer properties to additive content and methods to verify polymer quality (VTT)
    - T1.3 - Setting up safety margins for O-rings (RISE)
    - T1.4 - Ageing mechanisms of polymers in NPP containments (VTT)
  - WP2 - Improvements in ageing management of polymer components
    - T2.1 - Online condition monitoring techniques (RISE)
    - T2.2 - Sensitive analysing techniques (RISE)
    - T2.3 - Improved interpretation of non-destructive testing data (VTT)
  - WP3 – International cooperation

Task 1.1 - Improved estimation for lifetimes of critical polymer components (RISE)

- The goal is to estimate the residual lifetimes of different components and estimate what kind of safety margin assessment is required when making such estimates
  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

Task 1.2 - Sensitivity of polymer properties to additive content and methods to verify polymer quality (VTT)

- The aim is to understand how different additives affect to the ageing of a polymer and how sensitive the polymer properties are when an additive is changed, or its amount is altered in a polymer blend

  → Possible methods that can verify whether small changes in polymer blend's ingredients cause significant changes to ageing behaviour are introduced
- Verifying the use of the suggested techniques for analysing individual additives
- By the end of the project, the aim is to provide a list of techniques that can be used to analyse different additives, their amount, their reliability as condition indicator and effects on the ageing mechanism.

Task 1.3 - Setting up safety margins for O-rings (RISE)

- In task COMRADE work will be continued to be able to set realistic safety margins for O-rings
- Laboratory conditions are normally static whereas O-rings in service are exposed to thermal fluctuations and vibrations. Therefore aged O-rings will also be leak tested after exposure to simulated thermal and mechanical disturbance in order to set relevant acceptance criteria.
- Stress relaxation and compression set tests have been used in the ongoing project in order to evaluate the O-ring material and these material properties are used in the planned project as well

Task 1.4 - Ageing mechanisms of polymers in NPP containments (VTT)

- Continue studying irradiation and thermal effects on materials
- The effect of nitrogen atmosphere – how severe is the ageing of polymers when they are stored in air versus when they are in service in nitrogen atmosphere?
  - FTIR analysis to study oxidation products
- Additional analyses for currently aged materials
  - Swelling test
  - FTIR

Task 2.1 - Online condition monitoring techniques (RISE)

- Aim is to study the use of digitalisation and online measurements
- Techniques that monitor changes in the dielectric properties, e.g. impedance/dielectric spectroscopy and partial discharge
- The research question is how to design specific measurements methods and test samples sizes that are suitable for aging tests.
- The electric properties will be correlated to relevant material properties such as elongation, compression set and tightness etc. before and after ageing in order to verify the methodology.

T2.2 - Sensitive analysing techniques (RISE)

- Aim is to verify applicability of a sensitive technique which can detect ageing at early stage, microcalorimetry (MC)
- MC, like DSC, can register oxidation exotherms or any exothermic chemical and physical changes and it can 100-times more sensitive than DSC
- Small sample sizes allow studies on materials such as coatings, adhesives and seals
- The task comprises of a series of sensitivity studies, coupled with other techniques (e.g. detailed chemical analysis of the rubber before and after the trials) which can be used for the validation of the technique
- Correlation with traditional monitoring techniques such as hardness, compression set is needed

Task 2.3 - Improved interpretation of non-destructive testing data (VTT)

- How does the measured NDT response correlate to the material condition?
- Combined experimental work and computational modelling can be used to reveal these correlations
- The NDT methods whose output data can be interpreted using molecular dynamics simulations include: (i) ultrasound measurements, which could be correlated with the simulated mechanical response to small deformations. (ii) spectroscopy methods that probe the energy spectrum of many-body systems at atomistic level, such as infrared, Raman and terahertz spectroscopies imaging, (iii) micro-sampling based differential scanning calorimetry (DSC), which provides specific heat capacities and enthalpies of reaction, and (iv) nuclear-magnetic resonance (NMR), which could be correlated with simulated molecular mobilities.
- Using molecular dynamics simulations, the relevant NDT finger-prints are first analysed from the virgin material. The polymer is then aged to various degrees, and the evolution of the NDT fingerprints is followed through the aging process. The sensitivity of the NDT fingerprints to structural details is also analysed.