Contribution ID: **54**   Type: **Oral Presentation**

Fast neutron transmission spectroscopy for the non-destructive analysis of concrete

Wednesday, 5 July 2023 11:00 (20 minutes)

Concrete in nuclear facilities is primarily used to provide structural support, radiation shielding, containment and protection against internal and external hazards. Over its lifetime, the concrete will be exposed to unfavourable conditions such as corrosion, radiation, extremely varying temperatures and cyclic loadings. Exposure to these conditions leads to deterioration and loss of moisture thus compromising the shielding and structural integrity of the concrete [1,2]. This becomes relevant when considering the long-term operation of nuclear facilities. The Koeberg nuclear power plant (NPP) is nearing the end of its planned lifetime, and Eskom, overseen by the National Nuclear Regulator (NNR), is aiming to extend the life of the NPP by an additional 20 years [3]. Non-destructive measurements of the water content of these existing concrete structures are crucial to the process, both in terms of radiation shielding properties and the accuracy of Monte Carlo based radiation transport simulations [4].
In fast neutron transmission spectroscopy, the sample of interest is irradiated with a well-characterised beam of neutrons, and the transmitted neutron spectrum can be used to infer the elemental composition through a deconvolution technique [5]. In this work, we present an experimental and simulated verification of the technique using sand, a primary constituent of any concrete. Measurements were made at the n-lab at UCT [6] using a collimated beam of neutrons produced by an americium-beryllium (AmBe) neutron source, and samples of sand and its constituents CaCO3 and SiO¬2. Transmitted neutron energy spectra were measured using an EJ-301 organic liquid scintillator coupled with spectrum unfolding techniques, and subsequently used to determine the energy dependent effective removal cross section for each sample. A comparison was made with the removal cross sections obtained from simulations with FLUKA to validate the use of simulated data where physical measurements were impractical. The calculated ratios of CaCO3 and SiO2 in sand were verified against those obtained by x-ray fluorescence.

[1] Naus, D.J., The Management of Aging in Nuclear Power Plant Concrete Structures, Materials Issues in Nuclear Reactors, 61(7), pp. 35-40 (2009).
[2] Naus, D.J. et al., Nuclear power plant concrete structures – aging consideration, Challenges of Concrete Construction: Volume 6, Concrete for Extreme Conditions, pp. 747–764 (2002).
[3] World Nuclear News, Review of Koeberg extension plans completed by IAEA Team (2022).
[4] Petit, M., Concrete modeling for neutron transport and associated sensitivity stud- ies performed at the AMANDE-MIRCOM facility. Nucl. Sci. Eng., 195:8, 846 (2021)
[5] Hutton, T., Buffler, A. and Alexander, M. Elemental analysis of concrete via fast neutron transmission and scattering spectrometry, EPJ Web Conf., 261, 03003 (2022).
[6] Hutton, T. and Buffler, A., A new D-T neutron facility at UCT, Proc. SAIP2017, pp 324-330 (2018).

Apply to be considered for a student ; award (Yes / No)?

Yes

Level for award;(Hons, MSc, PhD, N/A)?

MSc

Primary author: Ms SEGALE, Naledi (University of Cape Town)

Co-authors: HUTTON, Tanya (University of Cape Town); Mr MHLONGO, Sizwe (University of Cape Town); BUFFLER, Andy (University of Cape Town)

Presenter: Ms SEGALE, Naledi (University of Cape Town)

Session Classification: Applied Physics

Track Classification: Track F - Applied Physics