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Nuclear safeguards assessments of molten salt reactor spent fuel

Molten salt reactors are a novel reactor design concept where the fuel is often used in a molten form. These reactors are believed to be safer and more efficient than the conventional light water reactors operating today. They also differ significantly in their design and operation and pose unique safeguards challenges many of which remain to be overcome. Some of these challenges arise from the fact that the safeguards guidelines that exist today apply mainly to itemizable fuel whereas nuclear material from these advanced reactors is usually in a molten matrix form. A deeper understanding of these aspects applied to molten spent fuel is imperative to effectively implement safeguards measures for these reactors. Traditional safeguards guidelines and practices may not be directly applicable and could require significant changes, something which motivates research on this topic.

Over the last two years, under a collaboration, researchers at Uppsala University have investigated nuclear safeguards-related challenges of molten salt reactors using the Compact Molten Salt Reactor developed by Seaborg Technologies as an example. The concept is envisioned to be an alkali-fluoride fueled reactor that can be placed on a transportable floating barge designed specially to house one or more units of this reactor. We present here results on assessments of material attractiveness of molten salt fuel using a newly formulated metric, the development of fuel isotopics datasets and implementation of machine learning algorithms for the prediction of salt's burnup, enrichment, and cooling time. This paper sheds some light on the research that has already been done and the ongoing and future work planned for floating type molten salt reactors in general.

Country OR International Organization

Sweden

Email address

vaibhav.mishra@physics.uu.se

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Author: MISHRA, Vaibhav (Uppsala University)

Co-authors: TROMBETTA, Debora (KTH); BRANGER, Erik (Uppsala University); GRAPE, Sophie (Uppsala University); MIRMIRAN, Sorouche (Seaborg Technologies); ELTER, Zsolt (Uppsala University)

Presenter: MISHRA, Vaibhav (Uppsala University)

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