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Protactinium presents a challenge for safeguarding thorium reactors

Since their conception in the 1950s, thorium reactors have been pursued as safer and cleaner alternatives to uranium-fueled reactors. Thorium fuel cycles have the potential to be more proliferation resistant compared to traditional uranium-plutonium fuel cycles, as they could produce less weapons usable plutonium, and the fissile U-233 generated will be protected by co-production of the highly radioactive U-232 isotope. Isotopically pure U-233 is an attractive material to potential proliferators [1]. The IAEA has specified that a significant quantity of U-233 is 8 kg. The proliferation risks of thorium reactors depend on the amount of U-232 present, which varies drastically based on reactor design, fuel burnup, initial fuel composition, and neutron flux and spectrum. While U-232 complicates handling U-233, it is unlikely that a typical reactor will generate U-232 content high enough to meet IAEA requirements for reduced physical protection [2].

This presentation will describe the major pathways by which U-232 is produced in thorium reactors. It will then describe how these pathways might be circumvented. Chemical reprocessing of recently discharged spent fuel would change the quantity of U-232 in the final U-233 product. Protactinium-233 (half-life = 27 days) is an intermediate formed in the production of U-233. Separation of protactinium during chemical reprocessing would be straightforward and may happen by accident. Chemical isolation of Pa-233, intentional or inadvertent, results in the production of isotopically pure U-233. In the future, IAEA Safeguards must verify that Pa-233 is not being diverted from thorium reactors. Therefore, despite their potential for proliferation resistance, thorium reactors will present unique safeguards challenges.

[1] C. G. Bathke, et al., The Attractiveness of Materials in Advanced Nuclear Fuel Cycles for Various Proliferation and Theft Scenarios. Nuclear Technology, 179, 5-30 (2012).

[2] J. Kang, F. N. von Hippel, U-232 and the Proliferation Resistance of U-233 in Spent Fuel. Science and Global Security, 9, 1-32 (2001).

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Which ”Key Question” does your Abstract address?

NEW1.1

Topics

NEW1

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