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ADS Fission in a Molten Salt Core - how to safely close the Nuclear Fuel Cycle

PETER MCINTYRE, Texas A&M University

The transuranic elements in spent nuclear fuel are the most enduring hazard of nuclear power. They have immense radiotoxicity, enough to jeopardize all life on Earth if they entered the biosphere, each reactor produces half a ton per year of them, and they have half-lives of hundreds of thousands of years. Innovations in accelerator physics and core neutronics make it possible to make accelerator-driven subcritical fission in a molten salt core (ADSMS) with which the transuranics can be safely destroyed by fission at the same rate they are produced in conventional power reactors. In ADSMS intense proton beams are produced by strongfocusing cyclotrons and delivered into a molten salt core. The core operates with a criticality of 0.96 - 4% of the neutrons needed to sustain fission. The protons produce fast neutrons in the core by spallation and drive fission. The core is designed with ultrafast neutronics, needed to fission the transuranics. The fuel salt is prepared by extracting the contents of spent nuclear fuel assemblies into molten salt using a non-aqueous pyroprocessing technology. Two designs of the ADSMS core have been developed: an Isoburner fueled only with transuranics for wasteburning, and an Isobreeder, fueled with a mixture of transuranics and depleted uranium from the spent fuel. The Isobreeder breeds fresh transuranics from the depleted uranium and burns them at the same rate, so that it can operate indefinitely by refueling periodically only with more depleted uranium and removing fission products. The Isobreeder opens the possibility to safely recover the entire energy content of uranium and thorium, and provide safe, abundant nuclear power for the next 2,000 years.