Molten Uranium Breeder Reactor - a Paradigm Change in Fuel Cycle

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ABSTRACT

This paper presents a concept for an innovative Uranium-Plutonium breeding (or near breeding) reactor that can completely upend the currently known avenues of the fuel cycle. The concept can be used for reactors sized from micro-reactors through small reactors to grid scale reactors, using mostly the LWR Used Nuclear Fuel (UNF) as initial fuel in melted metal form and burning it for very a long time (25-100 years) without refueling. All sizes of the reactors share common features:

- *The fuel is in the state of molten metal and circulated through a heat exchanger;*
- *The fuel is confined in large (~30 cm diameter) fuel tubes to increase fast fission;*
- *The reactor is heavy water moderated to reduce neutron loss;*
- *The power comes from thermal fission of U-235 and P_U-239, and fast fission of U-238.*
- *Many fission products naturally separate from the circulating molten uranium fuel either by evaporation because of the high operating temperature (~1400 ^oC) or by floating as dross because of the high fuel density and can be removed from the fuel circulation;*
- *The fuel cycle is breed and burn and operates without interruption until much of the U-238 undergoes fission either directly or indirectly.*

All features of the reactor concept reduce neutron loss so that the conversion ratio of the reactor is near 1. This low neutron loss also reduces the required fissile content to 5% or less, depending on the reactor size. For the Larger reactor sizes this allows the fuel to be mostly (50 to 90%) LWR UNF. The UNF is treated only to reduce the fuel oxides to metal, no isotopic separation or fission product removal is required.