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The once through model for use of nuclear material makes inefficient use of a valuable resource. In most circumstances, the once through model will only extract around 2% of the energy content of the total uranium resource. Reprocessing used fuel and its subsequent use as mixed oxide fuel (MOX), and the move towards recycle through the use of fast reactors, can increase the efficiency of resource usage. But therein lies the challenge –the need to make efficient use of energy resources against the need to minimise the proliferation risks associated with the spread of separated plutonium in the civilian sector.

Simply refusing to reprocess/recycle is not a long term solution to plutonium issues – it simply creates what are, in effect, plutonium mines which could be exploited by later generations of proliferators. Whereas the alternative, namely the reuse and recycle using fast reactors will, overtime, both degrade and consume plutonium, rendering it unavailable for future weapons use. That said, such processes will increase the amount of plutonium in the civil cycle over the short term.

Currently stockpiles of separated plutonium are being managed using thermal recycle of MOX in existing power reactors. This has been the case for over 25 years. During this period there has been no major incident or problem of safeguards or security significance. However, material accountancy, control and physical protection do require special attention at facilities using MOX. It is relatively simple to re-dissolve MOX and separate out plutonium. There is, therefore, an ongoing concern both about of the risks in the civil use of a potentially weapons usable material, and the number of countries operating MOX fabrication facilities.

The PUREX process for the reprocessing of irradiated (used) reactor fuel is well established and effective, but its spread among non-nuclear weapon states is undesirable as the process is primarily designed to separate pure plutonium product (which is then incorporated into MOX for subsequent use). It is possible to redesign the PUREX process to ensure that plutonium is always co-precipitated with uranium or a mix of minor actinides. But even under such a system redesign it would be possible to gain access to pure plutonium with only a small number of simple additional processing steps. Because the product of these process has low radioactive, it would remain a proliferation concern and would therefore require intensive effort on the part of the IAEA to safeguard.

Electro-processing (ie pyroprocessing) produces a product that retains substantial amounts of fission products. The fuel, suitable for use in fast reactors, is hotter and harder to handle than the equivalent PUREX product, which confers a significant degree of non-proliferation assurance. However, this material still poses some proliferation risk because a relatively simplified form of PUREX processing could separate the plutonium from the remaining fission products and actinides.

Possible alternative processes for recycling plutonium (or U233) which require further development include – the Direct Use of spent PWR fuel In CANDU (DUPIC) process, and the operation of high temperature gas-cooled reactors (HTGR) with thorium. DUPIC recovers some of the residual fissile value of PWR spent fuel by incorporating the spent fuel in CANDU fuel without reprocessing. HTGR operation with thorium involves the breeding of U233 and its subsequent consumption. While plutonium or uranium are necessary drivers in the initial stages, such reactors may be able to generate sufficient fissile material to sustain their continuing operation without reprocessing.

Future fast reactors can either be designed as net consumers or producers of fissile material. In burning mode they could be designed to optimise consumption of plutonium, minor actinides and long lived fission products, and reduce overall volumes of spent fuel and the length of storage required for high level waste. With appropriate management the spent fuel problem could be reduced to an issue of centuries rather than millennia.