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NUCLEAR REACTOR FUELLING METHOD FOR TRANSURANIC WASTE INCINERATION

The virtual elimination of long-lived highly radioactive nuclear waste may be achieved through a novel method of fuelling nuclear reactors using a mixture of Thorium and existing nuclear waste. Researchers in the Department of Engineering at the University of Cambridge have discovered that this new method can apply to either an existing water-cooled Pressurised Water Reactor (PWR) or a new reactor built to the proven PWR or Reduced Moderation Water Reactor designs. In addition to the removal of highly radioactive material from the environment, this method also provides a way to exploit the planet's considerable Thorium resources using existing well-proven reactor technology.

Key benefits of this technology include:

- Potential for elimination of worldwide stockpiles of long-lived highly radioactive nuclear waste
- Exploitation of existing well-proven nuclear reactor design and coolant, including extant reactors
- Increased availability of fuel compared with Uranium-based fuelling methods
- Reduced costs of waste storage due to shorter lifetimes / lower radioactivity
- Reduced risk of proliferation of weapons-grade material

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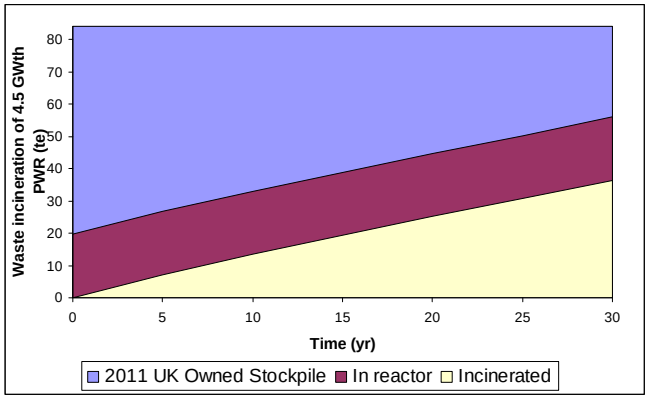
Background

The production of long-lived highly-radioactive waste is a major environmental and economic problem associated with nuclear reactors. Various techniques have been proposed to reduce or mitigate this concern but all suffer from further issues such as the need for new coolants or other materials, in immature reactor designs.

Researchers at the University of Cambridge have numerically demonstrated significant elimination of transuranic (TRU) waste, using the well-proven Pressurised Water Reactor (PWR) design, significantly reducing the risk and development cycle for implementation of the solution.

Figure 1: Modelled results showing incineration rate of TRU waste over half the reactor's lifecycle



Source: http://www.decc.gov.uk/assets/decc/Consultations/plutonium-stocks/1243-uk-plutonium-stocks.pdf

Technology

The known and proven PWR design is combined with a fuel mix of Thorium and normally arising nuclear waste. Appropriate design of the refuelling strategy maximises the elimination of TRU waste over the lifecycle of the reactor. It may also prove advantageous to modify the design of a PWR (or Boiling Water Reactor) by using a reduced-moderation fuel assembly.

Figure 1 shows the modelled results for a certain strategy and design that demonstrate that the UK's TRU waste stockpile could be significantly reduced by such a reactor. This process can be continued over a 60 year period such that the UK-owned TRU waste stockpile can be committed to the fuel cycle within the lifetime of one reactor. The incineration rate is then limited by the need for a large enough waste inventory to fuel the reactor while spent fuel is being reprocessed.

Energy generation using this approach compares well with alternative reactor designs. It has been shown numerically that the speed of incineration is comparable to that in a fast reactor, while burn-up is predicted to be at least as good as that currently achieved. Reactor availability and fuel reprocessing requirements are also expected to be similar to those of existing operating reactors.

It is important to note that no new materials or coolants are needed to implement this solution. The use of water as a coolant is safe and well-known, with extensive design experience in handling and managing the coolant in a PWR.

A further advantage of this design is that the TRU waste produced by the reactor during each fuel assembly cycle does not need to be removed for disposal. It is removed only in the course of reprocessing and fabrication into a new fuel assembly for reinsertion into the reactor.

The resulting reduction in waste storage requirements from this solution should lead to reduced costs and risks, and an improvement in public perception of nuclear energy.

Commercialisation

This solution is protected by patent application and we are now seeking industrial partners to work with us to develop the technology further.

If you would like to discuss how your company can be involved in this work please contact us using the details on the front of this sheet.