EURADWASTE ’04

Summary of the session on Partitioning and Transmutation

Partitioning and Transmutation: a technical fix or technical training?

Research in FP5 has seen significant technical advances in both partitioning and transmutation of highly active nuclear waste. In particular, our knowledge and understanding of chemical separation processes to extract highly active actinides from high-level nuclear waste has reached a level where scale-up to pilot plant scale is feasible. Design and supporting studies for an experimental accelerator driven system in transmutation are progressing. But, there is some controversy as to the value that the combined techniques can bring to the overall strategy of the geological disposal of nuclear waste.

One of the principle concerns in the disposal of radioactive waste is related to long-lived radionuclides, some of which can remain hazardous for tens of thousands of years. Partitioning and transmutation (P&T) is a possible method of reducing the long-lived component of radioactive waste, thereby easing the waste management problem.

Partitioning (chemical separation of long-lived minor actinides such as americium and curium from the high-level liquid waste from reprocessing of spent fuel) and transmutation (the nuclear conversion of these active actinides into less-active elements) has been the focus of a large cluster of projects in FP5 under the general title of Advanced Options for P&T – **ADOPT**.

Technical success

Three projects involved partitioning activities: two (**Partnew** and **Calixpart**) concerned the definition of advanced liquid-liquid extraction systems, while **Pyrorep** defined pyrometallurgical processes. Major progress has been made during FP5 to define and run extraction processes for long-lived radionuclides using liquid-liquid extraction at laboratory scale with the high selectivity required for a successful subsequent transmutation process.

According to Prof. Charles Madic: “Our knowledge is sufficient” to be able to demonstrate this process successfully at large scale, if required. Pyrometallurgical processes need further basic research because of the highly corrosive nature of the media involved.

A much larger group of clustered projects has concentrated on the transmutation of nuclear waste, and more particularly on transmutation in Accelerator Driven Systems (ADS). These include the Testra (Technological Support for Transmutation) cluster, the Fuetra (Fuels for Transmutation) cluster and Bastra (Basic Studies for Transmutation) cluster which all fed into the preliminary design studies for an experimental **ADS** project.

Three basic designs for an ADS have been studied: two based on a liquid metal cooling system of a lead/bismuth eutectic (systems rated at 80MW and 50MW respectively) and one gas-cooled device rated at 80MW. All designs feature a subcritical nuclear reactor, a heavy metal target, and an external linear accelerator. This fires high-energy protons into the target in the centre of the reactor to supply the extra neutrons (multiplied in the reactor), which can then transmute the high-activity waste into shorter-lived or inactive nuclides.

The three designs have been studied according to a common basis and the main future R&D requirements defined. All the designs have reached a level sufficient to identify the critical issues for individual designs and to suggest solutions. Major issues here are accelerator reliability and the lifetime of the metal spallation target. Other main issues are design of fuels for the system in order to maximise ‘burn up’ of long-lived actinides and the very large task of full engineering design. Licensing and regulatory approval of a demonstration device should also be considered at some point in the future.

Controversial elements

However, there is some controversy among the nuclear waste research community concerning the utility of P&T in waste disposal. The techniques are not a solution in themselves but, their proponents would advocate, a valuable adjunct to deep geological waste repositories.

Gerard Heusener, a well-known figure in nuclear research, chaired the P&T session at Euradwaste ’04. “P&T can bring the time requirement for the isolation of radionuclides in nuclear waste from our environment from timescales that are hard to imagine – hundreds of thousands of years or longer – into the realm of human experience. Human beings have built buildings that have lasted 1 000 years – for example, cathedrals. P&T can deliver waste that is no longer a problem in that timescale.” This could be a factor in establishing the credibility of nuclear waste solutions and could address many concerns about siting geological repositories in local communities.

A contrary view is that geological repositories can be built to ensure effectively no human intrusion and undesirable environmental impact in any time frame. In this case, P&T is an expensive option which does not necessarily add value.

The inclusion of transmutation projects in the Euratom Framework Programme is certainly valuable in retaining and ‘stretching’ nuclear engineering and technology expertise in Europe. Whilst ‘new build’ projects for nuclear power plants are rare in most Member States, there is a potential and perceived role for nuclear energy in future energy supply, in particular if policy-makers prioritise security of supply and greenhouse gas emission issues.

Experience gained in design and related studies for the ADS helps to conserve know-how and could lead to new, cheaper and safer nuclear power plants with lower waste production, should a renaissance occur in nuclear power. In addition, if P&T is shown to be a complete and viable option at industrial scale, this could enable new fuel cycles to be devised with an increased sustainable basis.