الأسبوع التاسع و العاشر

4.3. Radioactive Waste Management

Treatment and conditioning processes are use to convert radioactive waste materials into a form that is suitable for its subsequent management, such as transportation, storage and final disposal. The principal aims are to:

*Minimise the volume of waste requiring management via treatment processes.

*Reduce the potential hazard of the waste by conditioning it into a stable solid form that immobilises it and provides containment to ensure that the waste its can be safely handle during transportation, storage and final disposal.

It is important to note that, while treatment processes such as compaction and incineration reduce the volume of waste, the amount of radioactivity remains the same. As such, the radioactivity of the waste will become more concentrated as the volume it is reduced.

Conditioning processes such as cementation and vitrification are used to convert waste into a stable solid form that is insoluble and will prevent dispersion to the surrounding environment. A systematic approach incorporates:

* Identifying a suitable matrix material such as; cement, bitumen, polymers or borosilicate glass - that will ensure stability of the radioactive materials for the period necessary. The type of waste being conditioned determines the choice of matrix material and packaging.

* Immobilising the waste through mixing with the matrix material

* Packaging the immobilised waste, for example in; metallic drums, metallic container or concrete boxes or containers, copper canisters.

The choice of process used is dependent on the level of activity and the type (classification) of waste. Each country's nuclear waste management policy and its national regulations also influence the approach taken.

Incineration

Incineration of combustible wastes can be applied to both radioactive and other wastes. In the case of radioactive waste, it has been used for the treatment of low-level waste from nuclear power plants, fuel production facilities, research centres (such as biomedical research), medical sector and waste treatment facilities.

Following the separation of combustible waste from non-combustible constituents, the waste is incinerated in a specially engineered kiln up to around 1000^{o}C. Any gases produced during incineration are treated and filtered prior to emission into the atmosphere and must conform to international standards and national emissions regulations.

Following incineration, the resulting ash, which contains the radionuclides, may require further conditioning prior to disposal such as cementation or bituminisation. Compaction technology may also be used to further reduce the volume, if this is cost-effective. Volume reduction factors of up to around 100 are achieved, depending on the density of the waste.

Incineration technology is subject to public concern in many countries as local residents worry about what is being emitted into the atmosphere. However, modern incineration systems are well engineered, high technology processes designed to completely and efficiently burn the waste whilst producing minimum emissions. The incineration of hazardous waste (e.g. waste oils, solvents) and non-hazardous waste (municipal waste, biomass, tyres, sewage sludge) is also practised in many countries.

Cementation

Cementation through the use of specially formulated grouts provides the means to immobilise radioactive material that is on solids and in various forms of sludge’s and precipitates/gels (flocks) or active materials.

In general the solid wastes are placed into containers. The grout is then added into this container and allowed to set. The container with the now monolithic block of concrete/waste is then suitable for storage and disposal. Similarly in the case of sludges and flocks, the waste is placed in a container and the grouting mix, in powder form, is added. The two are mixed inside the container and left to set leaving a similar type of product as in the case of solids, which can be disposed of in a similar way.

This process has been used for example in small oil drums and 500-litre containers for intermediate-level wastes and has been extended to ISO shipping containers for low-level waste materials. The technology is being used in the immobilisation of many toxic and hazardous wastes that arise outside the nuclear industry and has the potential to be used in many more cases.

Vitrification

The immobilisation of high-level waste (HLW) requires the formation of an insoluble, solid waste form that will remain stable for many thousands of years. In general borosilicate glass has been chosen as the medium for dealing with HLW. The stability of ancient glass for thousands of years highlights the suitability of borosilicate glass as a matrix material.

This type of process, referred to as vitrification, has also been extended for lower level wastes where the type of waste or the economics have been appropriate. Most high-level wastes other than spent fuel itself, arise in a liquid form from the reprocessing of spent fuel. To allow incorporation into the glass matrix this waste that initially dried which turns it into a solid form. This product then incorporated into molten glass in a stainless container and allowed to cool, giving a solid matrix. The containers and then welded closed and are ready for storage and final disposal.

This process is currently being using in France, Japan, the Former Soviet Union, UK and USA and is seen as the preferred process for management of separated HLW arising from reprocessing.

In-situ vitrification also has been investigated as a means of 'fixing' activity in contaminated ground as well as creating a barrier to prevent further spread of contaminants.

Several other alternative ceramic processes have also developed which also achieve the desired quality of product.