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Harmless Disposal Techniques of Radioactive Nuclear Wastes - A Review

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ABSTRACT

In present time radioactive wastes are major problem for nuclear power countries of the world. Radioactive waste is usually a by-product of nuclear power generation and other applications of nuclear fission or nuclear technology radioactive wastes are defined as any material that contains by radionuclides at concentrations or radioactivity levels greater than the exempted level, based upon protecting public and worker health. Any material that is classified as a radioactive waste is required to be controlled to its uses, management and disposal, and also be isolated from the human environment for as long as necessary. Such wastes are produced from many processes in society but there are only a few which produce significant quantities of highly radioactive wastes.

Keywords: Radioactivity, Nuclear Reactor, Nuclear Wastes, Spent Fuel, Fission Wastes, Reprocessing, Fast Reactor

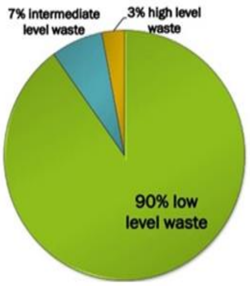
I. INTRODUCTION

Disposals of radioactive waste take into account permissible concentrations applicable from the particular issue of community safety. Ensure that the degree of dilution expect is achieved at discharge point (from the institution into the sewage system), and hazard to the general population is insignificant in the event of the slurry containing radioactive waste material

Radiation exposures throughout society over the last four decades of nuclear reactor development have shown that the various reactor cycle wastes constitute about 90% of all man- made radioactive wastes in the world, whereas medical radioactive materials constitute about 1% to 2% of all man-made radiation sources and associated wastes. Although, in terms of radiation doses to the general public, the specific and targeted uses of medical radiation have by far the bigger impact and are about 200 times larger. About 20% to 25% of the public average radiation dose in western society, comes from medical uses of radiation, while about 0.1% and less, arises from all of the processes relating to the operation of nuclear power facilities and their nuclear wastes.

1. Classification of radioactive waste:

Basically it can classified into three levels



Type of waste	Volume	Radioactive
High-level	3 %	94 %
Intermediate	7 %	4 %
Low-level	90 %	2 %

(1) Low level waste: This type of waste emits radiation at level which generally require minimal shielding during handling, transport and storage. They come from various nuclear activities including industrial and medical uses of isotopes and from research activities using radiation. Heat output is usually minimal and is typically much less than 2 kW/m3. This waste not require specific disposal actions.

(2) Intermediate-level waste: Intermediate-level waste emits higher levels of radiation and requires additional shielding during handling, transport and storage. They consist of different types and activities of wastes, usually from the reactor cycle: process filters ion exchange resins, chemical sludge's, and materials with generally greater radioactive contamination and associated dose rates. They also may include used industrial and medical devices and related isotopes. Which are not easily contained or packaged, can be stored in steel drums - perhaps filled with high density shielding and stabilizing materials such as sand, concrete or bitumen - before being placed into surface storage facilities for management and monitoring.

(3) High-level waste : High-level waste has higher levels of radiation which requires increased shielding and isolation from human contact and requires cooling due to its heat-generating capacity. It is produced from the operation of nuclear power plants. . They are made up mostly of spent nuclear fuel and/or separated fission wastes. Initially, in the case of spent fuel, they may require water-cooling for up to about 10 years to remove radioactive decay heat. Because these highly radioactive materials constitute such a low volume compared with their large energy production, the relatively few tons produced each year at each large reactor (from about 10 to 150 tones, depending upon the type and capacity of reactor.

II. CHARACTER OF WASTES

There are three type of radioactive wastes may be liquid, solid or gaseous with various degrees of radioactivity depending upon their origins and radionuclide content. Solid wastes are the easiest to manage and control. Liquid wastes containing long lived nuclides, may be concentrated and solidified. Where they contain short half-life nuclides they may be stored for a time to allow for decay, or diluted and safely dispersed into the environment. Most radioactive gases are of short half-life and can usually be safely dispersed to atmosphere under controlled and monitored conditions and over a prolonged period of time. Long-lived gases or volatile nuclides with properties that might allow cost-effective collection may be scrubbed from gas streams and, where possible, disposed as solids.

III. PRODUCTION OF WASTE

Production of Radioactive waste is at all stages of the nuclear fuel cycle – the process of producing electricity from nuclear materials. The fuel cycle involves the mining and milling of uranium ore, its processing and fabrication into nuclear fuel, its use in the reactor, its reprocessing, the treatment of the used fuel taken from the reactor, and finally, disposal of the waste.

3.1 Fuel fabrication through mining

Traditional uranium mining generates fine sandy tailings, which contain virtually all the naturally occurring radioactive elements found in uranium ore. The tailings are collected in engineered dams and finally covered with a layer of clay and rock to inhibit the leakage of radon gas, and to ensure long-term stability. In the short term, the tailings material is often covered with water. After a few months, the tailings material contains about 75% of the radioactivity of the original ore. Strictly speaking these are not classified as radioactive waste.

Uranium oxide concentrate from mining, essentially 'yellowcake' (U_3O_8), is not significantly radioactive but It is refined then converted to uranium hexafluoride (UF_6) gas. As a gas, it undergoes enrichment to increase the U-235 content from 0.7% to about 3.5%. It is then turned into a hard ceramic oxide (UO_2) for assembly as reactor fuel elements.

3.2 Electricity generation

The major source arising from the use of nuclear reactors to generate electricity comes from the material classified as HLW. Highly radioactive fission products and transuranic elements are produced from uranium and plutonium during reactor operations, and are contained within the used fuel. such as the cleaning of reactor cooling systems and fuel storage ponds, and the decontamination of equipment, filters, and metal components that have become radioactive as a result of their use in or near the reactor.

3.3 Reprocessing of used fuel

Any used fuel will still contain some of the original U-235 as well as various plutonium isotopes which have been formed inside the reactor core, and U-238. In total these account for some 96% of the original uranium and over half of the original energy content (ignoring U-238). Reprocessing allows for a significant amount of plutonium to be recovered from used fuel, which is then mixed with depleted uranium oxide in a Mixed Oxide (MOX) fabrication plant to make fresh fuel. This process allows some 25-30% more energy to be extracted from the original uranium ore, and significantly reduces the volume of HLW (by about 85%). The IAEA estimates that of the 370,000 metric tonnes of heavy metal (MTHM) produced since the advent of civil nuclear power production, 120,000 MTHM has been reprocessed. Commercial reprocessing plants currently operate in France, the UK, and Russia. Another is being commissioned in Japan, and China plans to construct one too.

IV. DISPOSAL OPTIONS AND WASTE MANAGEMENT

'Waste disposal' uses technically simple engineering principles that have been used for decades, That no significant permanent disposal of HLW has yet taken place is due to several issues: political indecision; activist opposition; lack of immediate need - because of the extremely low volumes of HLW; and uncertainty over the possible reversal of any premature decision that might involve discarding, rather than recycling an extremely valuable material - spent fuel. The term 'nuclear waste' is used to include spent fuel in those jurisdictions where re-processing is not practiced, or where the advanced fuel cycles are not yet considered as options. In reality, spent fuel is not waste. It still contains between 95 and 99% of unused energy. When discharged from the reactor it contains about 95% of the starting uranium-238; about 1% of unfissioned uranium-235 (in the case of spent enriched fuel); about 1% of fissionable transuranium nuclides; and about 3% of fission wastes. Only the latter is true waste at the present time. Spent fuel should not be considered for permanent non-retrievable disposal as it represents a valuable source of unused energy that will be required at some time in the future.

4.1 Disposal Methods:

(1) Deep-sea disposal:

Deep Sea Disposal was the most rational, safe and economic process for permanent, secure disposal, Thie process requires that the contained and solid wastes be encased in weighted cylinders to ensure deep penetration into the unconsolidated sediments directly above known subduction zones in the deepest ocean areas. However, deep-sea disposal is not generally considered at this time.

(2) Transmutation:

Transmutation process of changing one element to another to transform specific nuclear wastes into less hazardous materials. Transmutation is the process it is applied to reactor wastes of transforming the trans uranium radionuclides, and some long lived fission nuclides (e.g., technetium-99, iodine-129 and cesium-135) usually shorter half-life, and less dangerous.

This suggested process, which is being actively researched, uses a combination of proton accelerator, molten-lead moderation (producing hard neutrons by spallation) and sub-critical fission reactor technologies in a fast neutron system that is capable of producing electrical energy, or of transmuting long-lived radioactive wastes or some combination of the two. If the reactor is based upon thorium-232, then trans uranium wastes from the reactor cycle itself are negligible, as activation of thorium-232 is at least five neutron-absorbing steps removed from trans uranium nuclides.

(3) Others method : for dealing with nuclear wastes have been publicized from time to time, such as the suggestion to propel such wastes in rockets into the sun; injecting them into abandoned oil fields; or burying them beneath 'permanent' ice caps. They generally do not stand up to dispassionate scientific evaluation nor meet the long-term human security requirements. Deep borehole disposition of properly packaged, low volume HLW, is being examined as an alternative means of disposing of certain retired medical and industrial radioactive devices. The injection of liquid radioactive wastes by way of boreholes drilled into deep geological strata on land, was practiced for some time in the U.S., but encountered significant problems and was abandoned when it was discovered that these pressure-injected fluids were lubricating slip-fault zones, and triggering detectable seismic dislocations.

Radioactive waste disposal practices have changed substantially over the last twenty years. Evolving environmental protection considerations have provided the impetus to improve disposal technologies, and, in some cases, clean up facilities that are no longer in use. Designs for new disposal facilities and disposal methods must meet environmental protection and pollution prevention standards that are stricter than were foreseen at the beginning of the atomic age. Disposal of radioactive waste is a complex issue, not only because of the nature of the waste, but also because of the stringent regulatory structure for dealing with radioactive waste. India has achieved self-reliance in the management of all type of radioactive waste. Decades of safe and successful operation of our waste management facility stand testimony to international standards. An ongoing effort to upgrade technology to minimize radioactive discharge is also on.

V. CONCLUSION

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