RADIOACTIVE WASTE: AN OVERVIEW

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Energy is the most important component of infrastructure essential for growth and economic development of any country. It is one of the most challenging issues currently facing most of the countries. Industries and all world communities require energy for daily needs. We live in a world that is just beginning to consume energy.If the population of the world grows at the present rate, in the next 50 years – as world population expands to 9 billion and the energy needs are not met – it will severely hamper the human growth.

Clean energy from 'new renewable' sources such as solar, wind, biomass and hydroelectric power deserves strong support. But the collective capacity of these technologies to produce electricity in the decades ahead is limited. The International Energy Agency projects that, even with continued subsidy and research support, these new renewable energy sources can provide only around 6% of world electricity by 2030. As the price of oil and global warming concerns continue to rise steadily both have forced many countries to look for alternative source of energy which is clean, sustainable and efficient.The search of alternative energy source among the developed nations has led to a renewed interest in nuclear energy. The renewed interest in the clean-burning properties of nuclear power is become much more attractive today. The nuclear energy market is expected to grow substantially over the next 20 years and expected to double by 2030.

Production of electricity per capita is considered as one of the major development index of a country.The per capita energy consumption in many countries including China and India has increased. Among the power generation technologies,nuclear fission is one of them .The nuclear power generation has been developed since 1960 and now around 450 number of atomicfission power reactors are there over the world. In nuclear power production, the power generated from 1 gram of U is equivalent to the power generated from 2083 kg of coal. A large amount of energy released in exchange of small amount of nuclear fuel but the major problem in producing nuclear power is its radioactive waste.

The nuclear experiments have led some areas on earth to a radioactive waste storage centre and certain accidents from the nuclear power stations such as Chernobyl in Ukraine and Fukushima Daiichinuclear power station in Japan indicates a warning of hidden danger of radioactive pollution which is a big threat for environment. Radioactive waste management is becoming a major research area all over the world and its importance is increasing day by day.If the radioactive waste is not treated properly, it will harm the surrounding environment as well as life forms in the nature. Radioactive waste requires sophisticated treatment and management in order to successfully isolate it from interacting with the biosphere. This usually necessitates different types of treatments, followed by a long-term management strategy involving storage, disposal ortransformation of the waste into a non-toxic form. Therefore, radioactive waste management forms an important aspect of any nuclear establishment. Although the amount of radioactive waste generated is very small,

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when compared to wastes produced by fossil fuel electricity generation, safe radioactive waste management must be the primary priority of any nuclear programme.

The future development of nuclear power largely depends on the success of programmed and management of radioactive waste generated at various stages of the nuclear fuel cycle. Apart from the biological pollution, the industrial and the chemical pollution of the soil, nowadays there is also the radioactive pollution and the man is guilty for all of them.

RADIOACTIVE WASTE

Radioactive waste is any liquid, gas or solid that contains, or is contaminated with, radionuclidesat concentrations or activities greater than clearance levels as established by individual countries and regulatory authorities. It is a type of hazardous waste that is usually obtained as a by-product of nuclear power generation and other applications of nuclear fission or nuclear technology, such as research and medicine.

Radioactive wastes comprise of a number of radioisotopes which are having unstable configurations of elements that decay emitting ionizing radiations which can be harmful to the environment.Those isotopes which emit different types and levels of radiation, will last for different periods of time not just a few years but for thousands of years.All radioisotopes contained in the waste have a half-life i.e. the time taken for any radionuclide to lose half of its radioactivity. Thus, all radioactive waste decays into non-radioactive elements i.e. stable isotopes.The nuclei of radioactive substances spontaneously disintegrate to emitalpha, beta and gamma rays. The alpha rays consist of particles (nuclei of helium atoms) carrying a positive charge, beta rays particles have negative charge (streams of electrons) and gamma rays are charge less electromagnetic radiation with shorter wavelengths than any X-rays.These rays can penetrate living tissues for short distances and affect the tissue cells. It could take just seconds to die from exposure to such radioactive materials.It must be handled in the right manner so that it will not cause a ton of devastation in the world.

SOURCES OF RADIOACTIVE WASTE

Radioactive waste comes from a number of sources. In countries with nuclear power plants, or nuclear fuel treatment plants, the majority of waste originates from the nuclear fuel cycle and nuclear weapons reprocessing. Other sourceswhere much smalleramounts of radioactive waste are produced by the medical, industrial, research and defence sectors.

The‘nuclear fuel cycle’ is the sequence of industrial activities needed to generate electricity by nuclear power. It includes the manufacturing of nuclear fuel and management of spent nuclear fuel (used fuel). The nuclear fuel cycle is also called as nuclear fuel chain,is the progression of nuclear fuel through the front end of the reactor, where the preparation of fuel occurs, and in the service period in which the fuel is used during reactor operation, and in the back end, which are necessary to safely manage, contain, and either reprocess or dispose of spent nuclear fuel takes place.Primarily the radioactive waste originates fromnuclear power plants as nuclear fuel that is produced after being used inside of a nuclear reactor contains the most dangerous long-lived radionuclides which can last even for a century.

Waste from nuclear weapons decommissioning is unlikely to contain much beta or gamma activity other than tritium and americium. It is more likely to contain alpha-emitting actinides such as Pu-239 which is a fissile material used in bombs, plus some material with much higher specific activities, such as Pu-238 or Po.

Radioactive wastes produced by the defence sector arise in three main areas like Operation of active nuclear-powered submarines and the decommissioning of retired

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submarines; Clean-up of defence sites that may have been contaminated in the past; and Production, management and decommissioning of strategic deterrent nuclear weapons.The Ministry of Defence is responsible for the safe, secure and sustainable dismantling of retired submarines.

Radioactive materials are used for many purposes in the medical industry. In particular, radioactive materials are used to sterilise equipment, and help diagnose and treat medical illnesses.Relatively small amounts of radioactive waste are produced during the manufacture, use and recycling of radiopharmaceuticals.Radioactive medical waste tends to contain beta particle and gamma ray emitters. In diagnostic nuclear medicine a number of short-lived gamma emitters such as technetium-99m are used. Many of these can be disposed of by leaving it to decay for a short time before disposal as normal waste. Other isotopes such as I-131, Sr-89,Co-60are also used in medicine.

The industrial sector uses radioactive sources in a number of ways. The most common use is for non-destructive testing of materials and components. For example, gamma rays are used to test the quality of welds or the thickness of products, such as paper. Industrial source waste can contain alpha, beta, neutron or gamma emitters. Gamma emitters are used in radiography while neutron emitting sources are used in a range of applications, such as oil well logging.

TYPES OF RADIOACTIVE WASTES

The type of radioactive waste varies by country. Generally there are five types of radioactive waste- high level, low level, intermediate level, mining and milling and transuranic waste. All types of nuclear wastes have their own separate storage and clean-up procedures.

High-level waste is simply the spent fuel that is still present after it has been used inside of nuclear reactors. This radioactive waste has to cool off for several years and is considered to be very dangerous. The cooling process of this waste usually takes place inside of deep pools of water that are several hundred feet deep. This type of waste is hazardous to people for many reasons, but especially because it remains radioactive. High level waste accounts for 95% of the total radioactivity produced in the nuclear reactor. This type of nuclear waste is very dangerous. It must consistently go through a process to keep it cool and the radioactive material under control. High level waste can have short and long lived components depending upon the time it will take for the radioactivity to decrease to levels that is not considered harmful for humans and surrounding environment. In india, a key idea for the long term disposal of high level wastes is carried out by identifying suitable sites at which the waste could be buried, a process called deep geological repository (DGR) is followed by the department of atomic energy. Several areas of karnadaka and andra Pradesh were selected for the disposal and the after effects of improper disposalare still by the villagers.

Most of the radioactive waste that is around today is considered to be low level. About 90% of all nuclear waste is low level. Nuclear reactors, hospitals, dental offices, and similar types of facilities often use low-level nuclear waste materials on a daily basis. Low-level nuclear waste is not dangerous, and any of it can be disposed of inside of a landfill. It doesnot require shielding during handling and transport.The low level waste contains just 1% of the radioactivity of all radioactive waste.

Intermediate-level waste contains high amount of radioactivity than low-level and less than high-level. This type of waste typically requires shielding during handling and interim

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storage. This type of waste typically includes refurbishment waste, ion-exchange resins, chemical sludges and metal fuel cladding. The intermediate level waste contains 4% of all the radioactivity.

Tailings and waste rock are generates by mining and milling of uranium ore. The tailings material is covered with water and has the consistency of fine sand, when dried. It is produced by grinding the ore and the chemical concentration of uranium. After few months, the tailings material contains 75% of the radioactivity of the original ore.

Transuranic wasteis defined as waste that is contaminated with alpha-emitting transuranic radionuclides with half-lives greater than 20 years. Elements that have an atomic number greater than uranium are called transuranic ("beyond uranium"). Because of their long half-lives, it is disposed more cautiously than either low- or intermediate-levelwaste.Transuranic waste is much heavier than uranium. This type of waste is produced through nuclear waste reprocessing procedures in most cases.

DISPOSAL OF RADIOACTIVE WASTE

Radioactive waste is extremely varied in terms of physical and chemical form, radioactivity and the half-life of the radioactive elements it contains, as well as volume. A specific process is adopted for each category of waste, including a series of operations such as sorting, treatment, conditioning, storage and disposal.

Sorting: This consists in separating waste according to its different properties, in particular the half-lives of the radionuclides it contains. It also involves separating waste that can be compacted, incinerated or melted down to reduce the volume.

Treatment and conditioning: Different types of waste undergo different types of treatment (incineration, calcination, melting, compacting, cementation, vitrification, etc.). It is then sealed in a container. The result is a radioactive waste package.

Storage and disposal: Storage facilities are designed to accommodate waste packages for a limited period of time. Disposal is the final stage of the waste management processand should ensure that the packages must protect people and the environment both in the short and very long term.

In some countries, for very short-lived waste the radioactivity level of which disappears almost entirely in a few weeks to a few hundred days, is stored long enough to decay before disposal.High-level and long-lived wastewhich is in a liquid form, is mixed with molten glass and poured into stainless steel containers, then hermetically sealed by a welded lid. Once the glass has cooled down, the radioactivity is trapped inside the matrix.These wastes packages are currently stored by the organisations that generated the waste.

India has adopted closed fuel cycle optionif the spent fuel is reprocessed, it is referred to as a closed fuel cycle fuel. During reprocessing, only about two to three percent of the spent fuel becomes waste and the rest is recycled. At the end the high level waste will be emplaced in geological disposal facilities.The processing technologies adopted for management of radioactive waste are summarized below:

- *Solid waste:* Solid waste generated from nuclear power plants after suitable conditioning are disposed off in Near Surface Disposal Facilities (NSDF) located within the exclusion zone boundary of nuclear power plants. Near Surface Disposal Facilities are designed and constructed to contain the radionuclides within the disposal system until the radionuclides decay to negligible activity level.

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- *Liquid waste:* Low level liquid waste generated from nuclear power plants are discharged to the environment after suitable treatment and ensuring compliance with the regulatory limit. The treatment system essentially comprises chemical treatment, evaporation, ion exchange, filtration etc.
- *Gaseous waste:* Gaseous waste is treated at the source of generation. The gaseous wastes are discharged to the environment through 100 m high stack after filtration and dilution with continuous monitoring of radionuclides and compliance with the regulatory limits.

WHY IS RADIOACTIVE WASTES DANGEROUS FOR US?

Eventhough many countries are trying to achieve the goal of safe disposal of radioactive wastes, certain limitations exis regarding the dangerous drawbacks such as

There is no long-term storage solution: Even though nuclear power plants supply 11 percent of the world's electricity from 449 operating nuclear reactors, there are no safe long-term waste storage repositories.Our primary way of dealing with radioactive waste at the moment is to simply store it somewhere, and try to figure out what to do with it later. One commonly used "storage place" for decades have been our seas and oceans for their great capacity to dilute radiation.Clearly, this way of dealing with such a dangerous material is not safe, as the radioactive contamination spreads through our marine ecosystem.

Reprocessing nuclear waste is harmful: Nuclear waste reprocessing is highly polluting and is one of the largest sources of human-generated radioactivity on the planet. During this process, plutonium is separated through a series of chemical reactions from the spent uranium fuel. Plutonium is then used as a new fuel or to build nuclear weapons.Plutonium ranks amongst the most toxic substances ever known to humans. It accumulates in bones and liver, and makes it difficult to estimate its effects on individuals. Waste reprocessing is not an answer to the waste problem. In fact, the amount of waste left behind is higher. Chemical processes used to dissolve spent fuel rods generate significant volume of radioactive liquid waste, which needs to be safely stored.

Addressing the public's concerns and negotiating acceptable solutions is an important challenge regarding the radioactive wastes.At present,no single energy source excels in all measures. Each has some pros and cons. Although nuclear power has some challenges – notably waste disposal – it appears to be one of the most attractive sources in terms of a small environmental footprint, reliable energy generation, security of the energy supply, and other important measures. It should, therefore, be considered in this light in decision-making on future energy-supply options.

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