REVIEW ARTICLES

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Overview of Different Waste Treatment Methods

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ABSTRACT

Wastes including chlorinated aliphatic hydrocarbons, refractory organic compounds, aromatic derivatives, radionuclides etc., poses a serious threat to the environment. Therefore numerous in situ /ex situ treatment method are formulated to remove or immobilize such contaminates occurring in soil, water or air to minimize its harmful effects.

Key words: Front end nuclear fuel cycle; Nuclear medicine; Compaction; Sanitary landfills; Soil vapor extraction.

INTRODUCTION

Radioactive waste is waste with the potential to emit radioactive radiations and is termed as radioactive waste (Lutz*et al*.,1988). It is usually a by-product of nuclear reactions such as fission or fusion technology occurring in a nuclear reactor (Ewing*et al*.,1995). There are numerous sources of radioactive waste such as from nuclear power plants, nuclear deployment or nuclear fuel treatment plants, nuclear weapons reprocessing, biomedical and industrial wastes , radionuclides accumulation etc (Chapman *et al*.,1987).

Sources of Nuclear Waste

- **Front end nuclear fuel cycle:** It is usually uranium containing waste emitting alpha particles. It often contains radium and its decay products as well (Schneider *et al*., 2013).
- **Back end nuclear fuel cycle**: Waste containing fission products which emits beta/ gamma particles, and actinides that discharge alpha particles such as uranium-234 ,americium-241, neptunium-237, californium , plutonium-238 and 239 etc (Madic *et al*.,2007; Ewing *et al*.,2011)
- **Nuclear weapons decommissioning:** Waste produced from nuclear weapons neutralizing contains beta/ gamma particles, alpha-emitting actinides such as Pu-239 and Pu-238 or Po (Jo *et al*., 2007).
- **Legacy waste:** It includes abandoned waste from radium industry, uranium mining, and military programs (National Research Council, 2000).
- **Nuclear medicine:** Medical waste includes sources of beta and gamma ray emitters such as Y-90, Cs-137, Ir-192, I-131, Sr-89, Co-60 etc., (Cherry *et al*., 2012; Ravichandran *et al*., 2011)
- **Industry:** Industrial waste contain S alpha, beta, neutron or gamma emitters (Ojovan *et al*., 2011)
- **Naturally occurring radio nuclides:** Uranium and thorium radioisotopes from coal combustion, residues from oil and gas industry often contain radium and its decay products (Walsh *et al*., 2010).

Treatment of Nuclear Waste

Treatmentof nuclear waste

Radioactive waste is converted into a more stable forms that is neutral for the environment

The major objectives are as follows:

- Reduction of nuclear waste volume
- Minimizing the hazardous potential of nuclear waste by immobilization with inert matrix and containment.
- Strict regulation of nuclear waste management policy
- Storage of immobilized nuclear waste in impenetrable containers/canisters (Nash *et al*., 2011;Raj*et al*.,2006;Efremenkov *et al*., 1989).

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Nuclear Waste Treatment Methods

- **Incineration:** Combustible radioactive waste is incinerated in engineered kiln to reduce volume (Tzeng*et al.,* 1998). After incineration, the resulting radionuclide residues require further cementation preceding to disposal (Heberlein *et al.,* 2008).
- **Compaction:** Another technique is to reduce radioactive waste volume in compactors in order to be transported to a waste treatment facility for further compaction or to a storage/disposal facility (Burstrom *et al.,* 1987)
- **Cementation:** Away to immobilize radioactive waste into sludge, gels or fragmented solids (Osmanlioglu *et al.,* 2002).
- **Encapsulation:** A way to encapsulate non reprocessed fuel for long term storage (Suthanthiran *et al.,*1990)

Treatment of GroundWater Contaminants

Groundwater remediation involves the treatment of pollutants by transforming them into harmless forms in order tominimize the undesirable effects of contaminants (Lapworth *et al.,* 2012)

Ground Water Treatment Methods

- **Pump treatment method**: Extraction of contaminated groundwater from the subsurface to the pumping wells for treatment later the treated clean water is returned to the subsurface. Though it's a slow treatment process (Mackay *et al.,*1989)
- **Soil vapor extraction:** It involves the passage of large volumes of air through a polluted spill which causes evaporation of volatile pollutants into the air which are then transported to the surface (Mulligan *et al.,* 2001)
- **Bioremediation:** It involves the use of microbes for the biodegradation of pollutants present in the groundwater by stimulating the surrounding conditions through the addition of nutrients and oxygen to increase microbial degrading activity (Chapelle,1999)
- **Ion exchange:** Downward passage of water under pressure through a fixed bed of granular medium or spherical beads often made of zeolites and synthetic resins (Gupta *et al.,*2012)
- **Biosparging:** It uses native microbes to degrade organic contaminants present in the groundwater by stimulating the surrounding conditions through the addition of nutrients and oxygen to increase the biological activity of the microorganisms (Wilson *et al.,*1996).

Treatment of Soil Contaminants

Landfill technologies are intended to promote anaerobic biodegradation of organic waste (Evangelou *et al.,* 1998).

Soil Contamination Treatment Methods

- **Sanitary landfills**: It uses a clay liner to separate the waste from the environment and then deposited into thin layers for compaction in order to prevent the escape of potentially dangerous constituents (Chian *et al.,*1976).

There are three main types of this method

1. **Area method:** It involves the spreading and compaction of wastes then encapsulation with an inert material (Siddiqui *et al.,*1996).
2. **Trench method:** It involves the excavation of trench into which the solid wastes are spread, compressed and concealed (Reinhart *et al.,*1997) . The top of the finished landfill is raised above the original ground level (Pohland *et al.,*1973).
3. **Slope method:** The wastes are spread on an existing slope, compacted and covered (Singh *et al.,*1990).

- **Construction and demolition waste landfills**: Landfill use to manage the waste generated from construction, renovation, and demolition of buildings, roads, and bridges (Waste,1995).
- **Coal combustion residual landfills:** Waste landfill to manage and dispose of coal combustion residuals (Wadge *et al.,*1987).

Challenges of Landfill Waste Management

1. Groundwater contamination
2. Leachate production
3. Static load failures
4. Constantly rebuilding failing slopes (Zhang *et al.,* 2010; Guerrero *et al.,* 2013)

CONCLUSION

Thus the main aim of these contaminant treatment methods is to provide a safe and economical means of removing hazardous organic /inorganic waste from the environment either by completely degrading the contaminants in situ or ex situ in order to reduce the cost of treatment method.

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