https://doi.org/10.36375/prepare_u.iiche.a398

Nuclear Waste Management

Gagana M B

Affiliation: Gagana M B, Bapuji Institute of Engineering and Technology, Davangere, Karnataka, India.

Abstract

In the recent years the waste management has become a huge challenge to the global community. The nuclear waste which has radioactive components are causing a tough challenge to dispose. In various countries they have adopted methods like dumping the waste in sealing cans and burying in underground or below the sea bed which is very harmful to the environment and habitants. The radioactive waste has to be treated but without the human handling. So we can do it with the help of AIML and data science, where we can program the machinery to carry out the neutralizing process. As there is remains of radiation in the nuclear waste we can use it to form energy resources. Though it's very hard to manage but we still haven't found the safest way and with the current measure taken to dispose are very uncertain and do not ensure complete safety. Why bury it when we can convert it into some form of energy or useful resource.

keywords: Nuclear waste; Radioactive; Energy; Radiation; Technology.

Abbreviations

LLW- Low level waste

HLW- high level waste

AI- Artificial intelligence

AIML- artificial intelligence and machine learning

1. Introduction

The spent nuclear power of a reactor is the nuclear waste. The generation of the waste has been taking place since from 1960-1970. The world has already seen the destruction and harm caused by radioactive elements. The unstable nature of these elements release radiation when the disintegration of atoms takes place. The uranium and plutonium were the major elements which were used in creating nuclear power and weapons. The end product of the nuclear power generation is the nuclear waste which is hazardous and has radiation. The handling of these waste is done in different methods. Mainly the methods of incineration- treating the waste at high temperatures and evaporation techniques. The most widely used method is- sealing the radioactive waste in a multi-layered cans or tanks, which is mostly made of lead and also layering it with concrete and burying these cans in a geo-disposable site. These methods are considered to be safer and reliable, on the other hand some countries like France, Japan, Germany, Belgium and Russia are recycling the used plutonium to generate the electricity. The waste is classified into two levels ie., 1) Low and Intermediate level of waste 2) High level of waste. The high level of waste is very dangerous and is aqueous in state and has 99% of the radioactive radiation. It's a challenging task to handle this level waste and it shouldn't be exposed to living beings and to the atmosphere. There are various action taken to resolve this issue by adopting the methods of deep geological disposals. It is accepted as the safest method of disposal and is implemented.

In recent studies and publications various discoveries has been made and it is shown that LLW can be transformed and has shown its implementations in the field of medical sciences and technology. As there is a lot of undiscovered components left in the HLW. Instead of disposing it can it be transformed into some other form of resources? Or can there be any alternatives methods of handling this waste.

https://doi.org/10.36375/prepare_u.iiche.a398

2. Methods

Nuclear waste management is a critical aspect of the nuclear energy industry and is essential to ensure the safe handling and disposal of radioactive materials.

The emerging nuclear medicine is gaining lots of demand as there is a proof and studies been taking place regarding this topic. The LLW are already finding its implementation in this field but high level waste composition is much complex in its structure and there might be many useful things in this aqueous substance. Though it seems as impossible to experiment with HLW and analyse it more but the current emerging technology makes it possible.

The designing of special safety suits to protect human beings from radiation, temperature and toxic gases produced from the nuclear waste. We are currently using the safety suits designed from the Lead but to be in the environment where the handling of nuclear waste is taking place we need a advanced safety equipment's. The suits have to be experimented by exposing it to various aspects similar to its working conditions. As lead is also harmful to human beings, there creates a need of any other substitute other than lead. Tyvek 10000 and 2000 are currently in use but we need still more advanced to handle HLW. the suits better have GPS and at least some automatic parameter analysing technology.

Building of plants to process HLW. The process system be built in the nuclear power plant. This particular unit can be in small scale or large scale based on the percentage of the HLW produced in that particular plant. The material which it is built with should be corrosion resistant. We can use some technology that we are already implementing while dealing with volcanos and lava. The material of the bucket and ladle can be used as they are high temperature resistant. Some of the countries are converting used plutonium to generate electricity we can try to implement this technology even in case of HLW. if we could find ways in generating electricity as a product of HLW, this can be another source of energy. We can take the assistance of AI to monitor various parameters and AIML to manufacture equipment's, which can carry out the process of handling with HLW. by this we can prevent human beings working in the hazardous environment and reduces the risk of getting exposed to radiations.

Finding an alternative to generate nuclear energy. We are using uranium and plutonium currently to generate nuclear energy. The mining of the uranium is very hazardous and difficult. We have already seen the deformities

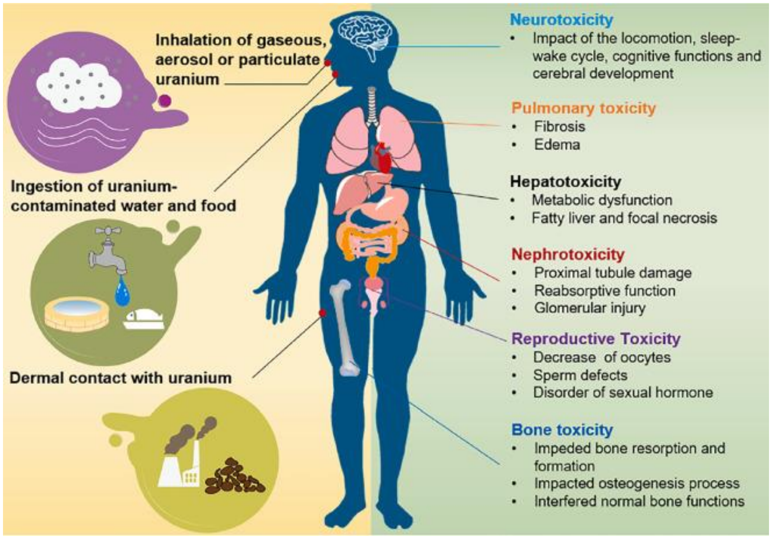

Figure1Emerging health risks and underlying toxicological mechanisms of uranium contamination: Lessons from the past two decades https://www.researchgate.net/figure/The-primary-exposure-routes-and-health-risk

it has caused in the workers who have worked in the mining and uranium is not available abundantly everywhere. we can find some other element which is not harmful and doesn't

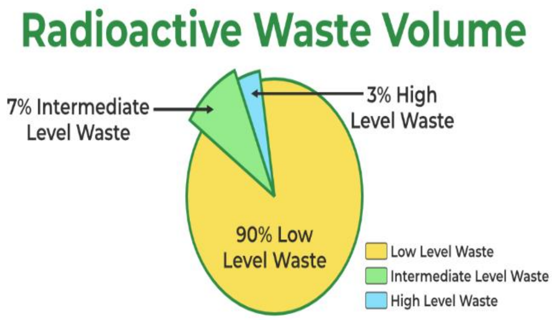

Figure 2 GeeksforGeeks. (2023, February 13). Radioactive waste and pollution. GeeksforGeeks. https://www.geeksforgeeks.org/radioactive-wastes-and-pollution

emit radiations. This element has to be sustainable, economic and available abundantly to generate power. It should be perfect alternative for uranium with no hazardous impacts.

https://doi.org/10.36375/prepare_u.iiche.a398

3. Results

The processing of any material has many processes. The nuclear power plant which can take on HLW should be situated in a isolated and a very ideal conditions of environment. This particular field of research need experts of the various domains to work together to find the solution. There are still several elements which are not discovered and this brings forth

Type of uranium	Composition (%)	
	^{235}U	^{238}U
Natural uranium	0.7	99.3
Slightly-enriched uranium	1.0-1.8	≈98.5
Low-enriched uranium	3	97
Weapon-grade uranium (WGU)	93.5	6.5

Figure 1 [PDF] The long-term nuclear explosives predicament : final disposal of military usable fissile material in nuclear waste from nuclear power and from the elimination of nuclear weapons | Semantic Scholar

a speculation of an element in existence which can help us in finding the solution of the issue.

As the artificial intelligence is finding its implementation in various fields and technology, it can assist us in dealing with the nuclear waste as well and also take on the works that is hazardous for the human beings to involve. We can design the machines in a way where nothing harmful is emitted and gets out of the system to the environment.

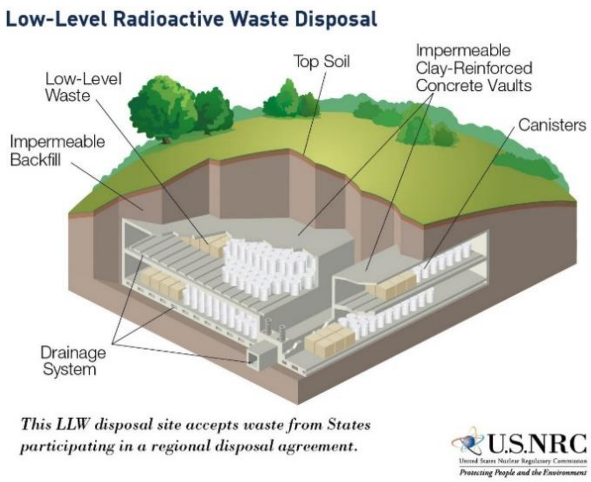

Figure 4 NRC maps of radioactive waste sites. (n.d.). NRC Web. https://www.nrc.gov/reading-rm/doc-collections/maps/radioactive-waste-sites.html

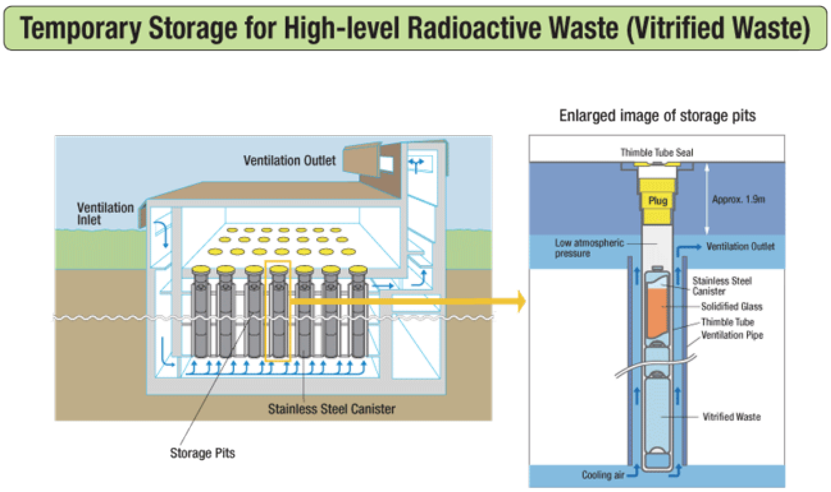

Figure 5 High-level Radioactive Waste (HLW) Management - The Federation of Electric Power Companies of Japan(FEPC). (n.d.). https://www.fepc.or.jp/english/nuclear/waste_management/high-level/index.html

4. Discussions

The present generation is in need of sustainable and reliable form of energy. With ever increasing demand for energy, the fossil fuels are unable to fulfil the demand. The pollution caused and as the coal is near to extinction, we need other forms of energy. We are currently using many available forms of energy but we are in need of high electric power supply with less consumption of resource. When the world was introduced to the energy equation $E=mc^2$, the nuclear energy came into existence and we knew that it could fulfil the energy demand. But the end result of the nuclear energy generation ie., nuclear waste caused the huge problem and debates around the world. If we can find the most suggestable method to handle the nuclear waste then we can nearly overcome the energy crisis. We can try to convert the nuclear waste into some other form of energy or find a absolute no harm disposable method. The geological disposable method can only postpone the effects for now but eventually in the it will cause problems in future. But why dispose it when we still have the room for converting the waste into something useful. Most of the powerful nations which are producing nuclear energy have technology to use the nuclear energy but there is still no invention about how to handle the waste with a success rate of 100%. In recent days, there has been disposable of nuclear waste water(treated) into water bodies which is very concerning as it may contain toxic materials in it. These incidents indicate that there is a need for better disposal method of any state of waste which is associated with the nuclear energy.

Acknowledgement

I'm greatfull to my parents who have supported me to write this paper. Thank you to my father Mr. M. Basavaraja, who motivated me all through the journey.

References

1. Alwaeli, Mohamed, and Viktoria Mannheim. 2022. "Investigation into the Current State of Nuclear Energy and Nuclear Waste Management—A State-of-the-Art Review" *Energies* 15, no. 12: 4275. https://doi.org/10.3390/en15124275

2. Weber, W.J., Navrotsky, A., Stefanovsky, S. *et al.* Materials Science of High-Level Nuclear Waste Immobilization. *MRS Bulletin* **34**, 46–53 (2009). https://doi.org/10.1557/mrs2009.12

3. Niemeyer, I. (2023). Panel: safeguarding nuclear waste management. Safety of nuclear waste Disposal, 2, 205-205. https://doi.org/10.5194/sand-2-205-2023

4. Ringwood, A. (1985). disposal of high-level nuclear wastes: a geological perspective. Mineralogical Magazine, 49(351), 159-176. https://doi.org/10.1180/minmag.1985.049.351.04

5. Jenkins-Smith, H., Silva, C., Nowlin, M., & deLozier, G. (2010). Reversing nuclear opposition: evolving public acceptance of a permanent nuclear waste disposal facility. Risk Analysis, 31(4), 629-644. https://doi.org/10.1111/j.1539-6924.2010.01543.x

6. Noka, V. (2023). The role of nuclear cultural heritage in long-term nuclear waste governance. Safety of nuclear waste Disposal, 2, 227-228. https://doi.org/10.5194/sand-2-227-2023

7. Enderle, S. (2023). Solving problems collectively in nuclear waste governance. Safety of nuclear waste Disposal, 2, 267-267. https://doi.org/10.5194/sand-2-267-2023

8. Ramana, M. (2018). Technical and social problems of nuclear waste. Wiley Interdisciplinary Reviews Energy and Environment, 7(4). https://doi.org/10.1002/wene.289

9. Ewing, R., Whittleston, R., & Yardley, B. (2016). geological disposal of nuclear waste: a primer. Elements, 12(4), 233-237. https://doi.org/10.2113/gselements.12.4.233

10. Birkhölzer, J., Houseworth, J., & Tsang, C. (2012). geologic disposal of high-level radioactive waste: status, key issues, and trends. Annual Review of Environment and Resources, 37(1), 79-106. https://doi.org/10.1146/annurev-environ-090611-143314

11. Frankel, G., Vienna, J., Lian, J., Guo, X., Gin, S., Kim, S., … & Scully, J. (2021). Recent advances in corrosion science applicable to disposal of high-level nuclear waste. Chemical Reviews, 121(20), 12327-12383. https://doi.org/10.1021/acs.chemrev.0c00990

12. Hoyer, E., Kreye, P., Lohser, T., & Rühaak, W. (2021). Preliminary safety assessments in the high-level radioactive waste site selection procedure in germany. Safety of nuclear waste Disposal, 1, 37-38. https://doi.org/10.5194/sand-1-37-2021

13. Näslund, J., Brandefelt, J., & Liljedahl, L. (2013). Climate considerations in long-term safety assessments for nuclear waste repositories. Ambio, 42(4), 393-401. https://doi.org/10.1007/s13280-013-0406-6

14. Segall, G., Grady, E., Fair, J., Ghesani, M., & Gordon, L. (2017). nuclear medicine training in the united states. Journal of nuclear Medicine, 58(11), 1733-1734. https://doi.org/10.2967/jnumed.117.200857

15. Sram, R., Dobiáš, L., Rossner, P., Veselá, D., Veselý, D., Rakusová, R., … & Rericha, V. (1993). Monitoring genotoxic exposure in uranium mines.. Environmental Health Perspectives, 101(suppl 3), 155-158. https://doi.org/10.1289/ehp.101-1521117

16. Zhang, Z., Tang, Z., Liu, Y., He, H., Guo, Z., Feng, P., … & Sui, Q. (2023). Study on the ecotoxic effects of uranium and heavy metal elements in soils of a uranium mining area in northern guangdong. Toxics, 11(2), 97. https://doi.org/10.3390/toxics11020097

17. Kautsky, U., Saetre, P., Berglund, S., Jaeschke, B., Nordén, S., Brandefelt, J., … & Andersson, E. (2016). The impact of low and intermediate-level radioactive waste on humans and the environment over the next one hundred thousand years. Journal of Environmental Radioactivity, 151, 395-403. https://doi.org/10.1016/j.jenvrad.2015.06.025

18. Ojovan, M., Robbins, R., & Garamszeghy, M. (2017). Advances in conditioning of low- and intermediate-level nuclear waste. Mrs Advances, 3(19), 983-990. https://doi.org/10.1557/adv.2017.613