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Research Article

Disposal of E-Wastes Containing Lead by Deep Geological Repository

Franklin Joseph Selvan*

University of Technology, Sydney, Australia

ABSTRACT

The disposal of e-waste containing lead has been one of the many crucial challenges in the field of e-waste disposal. This project deals with curating a new methodology for disposing e-waste containing lead through a deep geological repository. The lead waste would be buried few meters below the ground level in an enclosed container, thereby preventing interaction between its surroundings. This particular idea was derived from the disposal of nuclear waste through a similar procedure using deep geological repository. The procedure is also suggested to be one of the safest methods for disposing nuclear wastes. Lead waste from electronics tend to contain harmful acids which can contaminate the environment leaving behind harmful residue. The various steps needed for the establishment of a deep geological repository have been studied. The conventional method for disposing e-waste containing lead was to dump it in a landfill which could result in an environmental threat. This indicates that the successful implementation of the current project can be of great advantage for developing countries to have a method of safe e-waste disposal for lead which may cause lesser environmental damage.

Keywords: Deep geological repository; E-waste; Lead waste

INTRODUCTION

Lead can be a very toxic element for human beings and can cause many health issues. Therefore, it is super important to dispose lead particles in a safe manner. This study deals about the disposal of E-waste containing Lead by the method known as Deep Geological Repository. E-waste containing lead has been regarded has rapidly enhancing in waste streams of many developing cities. The development of digital technologies has led to accumulation of e-wastes containing lead which can possess a major threat to the humanity if not treated properly. The term E-waste is a collective term coined for electronic utilizations including the basic appliances such as refrigerator, air conditioner and television. Lead is present in significant amounts in cathode ray tubes of a digital screen and television. A study estimated that disposal of 500 million computers in the world can produce almost one ton of lead making it highly dangerous to the humanity [1]. Most of the led wastes have been dumped in sanitary landfill which would mix into water streams and habitat of humans [2]. This study would analyze if a geological repository can prove to be an efficient disposal method. This technique had been used to dispose nuclear wastes in many countries. Since there is no proper procedure for the disposal of lead, the deep geological repository can be an effective method.

There are not many researches on disposal of lead by a deep geological repository, hence this study would need to link researches and articles of nuclear waste disposal carried out by deep geological repository. Extensive reading about the deep geological repository would be done so that customization can be done to lead wastes since they are not radioactive, the depth of the deep geological repository can be in the range 50-100 meters. The deep geological repository has been considered a long term result for nuclear waste disposal in protecting the environment from the hazardous rays. Therefore, the deep geological repository can provide an answer for the disposal of e-waste containing lead, the only downside would be the initial investments however it protects the environment.

This project would provide the methodology of the setup and how the process would be carried out, the duration of the project and the feasibility and practicality when carried out in real life. The depth of the repository, the location of the deep geological and soil assessment will be studied in detail by accessing various journal articles. Confirming that lead disposal through geological repository would aid in enhancing environmental safety by minimizing pollutants could be a key discovery. For example, this would be possible since the pollutants would not blend with open water. These possible findings would alleviate health hazards imposed on people. It is evident that the cost of the entire project would suggest being worth considering the numerous benefits it offers.

LITERATURE REVIEW

According to researcher when e-wastes are discarded without any

***Corresponding to**: Franklin Joseph Selvan, University of Technology, Sydney, Australia, E-mail: franklinjoseph43@gmail.com

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proper caution it causes negative effects to the ecosystem. The most common e-wastes are the display screens and cathode ray tubes containing a significant amount of lead, which possess major threat to human beings. The article mentions that the India and China has the greatest number of fractions of e wastes and followed by countries in Africa since they are not densely populated as the latter. The e wastes are being handled by labours with improper training and equipment. The paper concludes that even though there had been various legislative actions taken by waste management bodies on a global scale it still has not been reduced.

According to Huo et al. [3] lead is one of the most hazardous e-wastes since it is present in many electronic devices and it enters the living being through either food or the atmosphere and affects children the most. This study is based on a town named Guiyu in china where recycling of e-waste occurs. Blood samples were collected from over 100 kids to calculate the lead content in the body and the blood lead levels of the children were reported to be contain high percentages of lead in their body. The lead wastes have been drifted through the wind or water and seemed to affect the population in the nearby city.

The E-wastes containing lead can be reused, recycled or disposed in landfill however studies show that most of the wastes are being sent to developed countries where it is dumped in the landfill flowing into water streams. Landfills are considered an unacceptable way of disposal by any environmental organization as it pollutes the atmosphere and contaminates the soil. It is stated that the lead pollution from cathode tubes when they are disposed through incineration reduces the harm of pollution at soil level but still there are some negative effects to the environment. The author claims that the present practices for disposal is not an efficient method since it is sent to developed countries and then disposed into landfills.

According to Mundada, et al [1] the lead waste from a printed circuit board if mixed is very toxic to human health and when exposed it can directly affect the central nervous system. The author also claims that the accumulation of lead in municipal waste lines to have increased over the years which calls for a proper disposal or a recycle system for e-wastes containing lead. A monitor can contain up to half a kilogram of lead which can go in the atmosphere when disposed in an unmanned landfill. The most dangerous e-wastes are from the cathode tubes and glowing digital screens which contain lead oxide. Lead can affect children causing underdeveloped IQ activity and stated by Environmental protection authority (EPA) that it is carcinogenic. E-wastes from United states are being sent to cities in India to dismantle and reusing however these are handled by untrained workers.

The deep geological repository has been considered one of the safe methods of disposing nuclear wastes. In this article surveys were made by screening people of nuclear radiation in a particular radar. It was found that the radiation effect to the human beings were less than the harmful limit .There were screening tests taken to even animals which were habituating near a wetland and it was examined that there was no harm to the biota of the surroundings .Hence this paper claims that a repository would not affect the natural habitats of living beings proving it to be a very efficient disposal technique [4].

According to [5] E-wastes have been a major problem in the present scenario.The most dangerous E-wastes are from cathode ray tubes and display screens. The Author states that since this is the era of technology there has been so much surge in the usage of electronic products which eventually adds to the E-wastes. The occurrence of lead in the electronic wastes leads the significance of safe disposals. Globally there has been a noteworthy growth in the selling of electronic products resulting in the increase of E-wastes. It has been mentioned that in developing countries like India the recycling for parts had been done by untrained labours which makes it hazardous since the e-wastes contain harmful materials. The exposure of lead to human beings can affect reproductive system, the kidneys and the nervous system.

According to researcher one of the most harmful e-waste is lead, it was seen that global e- waste was more than 50 million tones and increased annually by 10%. The author states that more than 75% of the E-waste are illegally sent to developing nations and are dumped in unmonitored landfill. Out of all the E-wastes the most hazardous was found to be lead which affects the respiratory system especially the people who reside these landfills. A survey was taken for the children living near these e-waste dumpsites and it was found that almost 60%had lead deposits on their lungs. This article addresses that there should be high precaution given to e-wastes especially when there are heavy metals like lead which can be a threat to the humans and surroundings [6].

In the Unites states the nuclear waste were disposed by building a deep geological repository in the Yucca mountains which was away from the surroundings of the people. This article states that the repository disposal for nuclear waste was one of the efficient methods even though the initial capital was high [7].

DEVELOPING COUNTRIES AFFECTED BY E WASTE

The e-wastes are dumped illegally in landfills in most of the developing countries. These E-wastes can contain lead making it harmful for the human beings. Frequent exposure of lead can lead to nervous damage especially in children. Tons of e-waste is exported to developing countries since they do not have much environmental legislations. The developing countries make some money by selling the scrap parts from the electronic wastes. The e-wastes are handled by untrained labor who does not know the harmful effects of these contents. Researches have shown that if there are no steps taken in the reduction of the e-wastes it can be a significant problem for the upcoming generation [8].

According to Joseph [9] the e-wastes in India often mix with streams. These streams are being used as a source of drinking water in many locations. When this water is consumed by the humans the levels of lead in their blood increase and it can lead to various diseases.

METHODOLOGY

The methodology used in this project is qualitative analysis and is explained below.

Technical study of a Deep Geological Repository

The construction and setup of repository is analysed by reviewing several research articles based on waste disposal using repository technique. The depth of the bedrock would be determined for the placement of the repository. The evacuation of the soil would be carried out by tunnel boring machines [10].

Biosphere Assessment methodology of analyzing soil nature

One of the principle methods of this project would be the biosphere assessment method which is primarily for the deep geological repository where site selection takes places, site would be assessed, and the materials associated in the setup of a deep geological repository.The Bedrock offers high compressibility and tensile strength for the construction of a deep geological repository.

Analysis of harmful concentration of Lead waste

The lead wastes when mixed with a leaching solution in the ratio 1:20 and the solution would be tested for the concentration estimation of lead. If the mixture contains more than 5 mg per litre it is very harmful for the environment and necessary precautions must be taken for the lead disposal [11].

Technical study of difference between Lead and Nuclear waste

It is important to examine the differences of the both the wastes so that the depth can be altered conferring to the concentration of the waste. The lead wastes do not penetrate as much as the nuclear wastes and are not radioactive. Hence the depth of the deep geological for lead disposal can be made much lesser than the nuclear wastes.

Review of material used in the Repository

A container should be chosen of high corrosion resistant property, the lead wasted would be infused in these containers and be buried underground. Another criterion in the selection of the container is to withstand high pressure since they would be buried deep into the ground [12].

SETUP OF DEEP GEOLOGICAL REPOSITORY

The experimental setting can be explained by the following stages:

Permission from a Government body or an Environmental Organization and site selection

The entire research would be demonstrated as a prototype or a conceptual model to the government in order to receive the grant. The benefits on how the environment can be protected from lead wastes would be clearly stated to the higher authorities. The site selection would be usually away from the human surroundings. This stage to seek the grant could be challenging since the setup is expensive than the conventional methods of disposal.

Analysis of soil nature

In this stage the soil is closely analysed to check for the feasibility for the construction of the repository. In this stage the bed rock and the host rock would be checked for their characteristics favouring the construction of the repository. These features of the soil levels would be marked on a scoring chart. These measures would be useful in determining the weight and dimensions of the repository [13]. The bed rock is the level which is in favour for the construction of the repository because it offers high compressibility and tensile strength. The bed rock is usually situated 15 metres below the ground.

Selection of the thickness of the repository and number of layers

Since the lead wastes are not radioactive and do not penetrate much, the thickness can be less than one meter and a single layered wall must be suitable. According to Allushllari et al. [14] the lead wastes can penetrate the soil up to 100 cm. In this case the repository depth would be placed 25 meters underground so it would be very secured and there would not be any penetration of lead waste into the atmosphere.

Material selection for the cylinder where the lead wastes would be infused

Titanium alloys would be used in this research for the cylinder. The titanium alloys have excellent corrosion resistant properties and high tensile strength .Since the repository would be buried 25metres below the ground there are high chances of the material getting corroded and also they would face a lot of pressure.The titanium alloys are considerably light in weight when compared to the other metals and are economical. The titanium alloys have been used in the manufacture of gas turbines and hence the material would not erode on exposure to lead wastes [15].

Sensors to be setup to monitor

It is highly significant to monitor the situation happening underground. These sensors play a vibrant role in the long-term maintenance of the waste repository. This monitoring setup would send information about the soil disturbance, mechanical disturbance and temperature changes. The monitoring system would have numerous sensors setup measuring various parameters. Since the disposal system is underground, drilling every time when there is an issue would be a very tedious and expensive process .Hence the monitoring and data acquisition systems will enrich the lifetime of the deep geological repository [16].

A thorough safety analysis is to be performed

This is the last stage in the setup of the repository where the entire construction is checked for safety. The bedrock would be checked for stress analysis, the waste cylinder would be closely monitored to check for any leakages. The entire system would be run and checked if its ready to be used [17].

DETERMINING THE DEPTH OF DEEP GEOLOGICAL REPOSITORY

The soil basically is classified into few types namely the topsoil, subsoil, parent rock and the bed rock. The Topsoil usually contains roots and clayey layer which do not offer good characteristics to build a repository. Seven to 10 meters below the ground there is the parent rock which entails withered rocks [18]. The parent rock offers good compressibility when compared to the topsoil and the subsoil. From 15 meters the bedrock is present which offers great compressibility and high tensile strength.

The lead wastes when buried 25 meters below would be completely separated from the atmosphere and the surroundings. Since the lead wastes are not radioactive it would be completely secure for them to be at 25 meters below the ground.

Reasons supporting the depth of Deep geological

repository to be 25 Metres:

- The setup can be placed as it is for the next 20 years or so even with gradual soil erosion happening.
- The bedrock is at least 15 meters into the ground which provides good mechanical characteristics for the construction of the repository.
- Lead wasted would be totally separated from the underground and the natural surroundings.
- Cost effective method since the drilling is going to be done only till 25 meters [19-21].
- The Maintenance will be much simple.

RESULTS AND DISCUSSIONS

Once the lead wastes are infused in the deep geological repository. There would be zero interaction of the lead wastes and surroundings. Therefore, the surroundings would be less polluted, and the human health would be restored. The deep geological method can prove to be a feasible long-term solution for e-wastes containing lead. There would be no penetration effect of lead into the atmosphere.

This Project can work as collaboration with industries which take care of e-wastes especially in the developing countries. A small-scale model can be designed to test it if it can be feasible in a given country.

The limitations of this experiment are the high cost associated with the setup however it is a one-time investment and would be a long-term solution. Since this experiment would reduce the externalities caused by e-wastes containing lead it is worth spending on a high capital. The other limitation is that it will need a lot of space for the setup and grant from the government or environmental organization which might be a tedious task.

This procedure will not only safeguard the current generation but also the upcoming generation.

CONCLUSION

Since the current epoch has been facing a lot of problems in disposing e-wastes which contain lead, the above project provides an ideal solution for disposing lead wastes in the form of a deep geological repository. Although the initial investment on the deep geological repositories is expensive, it turns out to be cost effective in the long run. This investment indeed may be priceless considering its beneficial effect on the environment. Furthermore, this project can be a good long-term solution since the wastes are kept underground and do not interact with the surroundings, hence improving the quality of life for the human being and also improving the surroundings. The deep geological disposal method for e-wastes containing lead can be adapted in developing countries where there is a considerable amount of e-wastes.

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