

Section 3. Chemistry

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*Rui (Thomas) Guo,
Culver Academies in Culver, Indiana.*

FUKUSHIMA NUCLEAR ACCIDENT ENVIRONMENTAL IMPACT AND POSSIBLE SOLUTION ANALYSIS

Abstract. This paper first introduces the background of the Fukushima nuclear accident. Then it discussed how the presence of certain elements and chemicals in the polluted water can be a problem and the extent of its impact. Three solutions, which are remote robot, release of water into the Pacific, and electro filtration, are evaluated, and electro filtration is recommended.

Keywords: Fukushima, nuclear reactor, radioactivity, electro filtration.

Introduction

“The Sun is the only safe reactor, situated as it is some ninety-three million miles away.” This quote came from Stephanie Mills, an American singer. On March 11th, 2011, Fukushima nuclear plant, one of the largest nuclear stations in the world, melted down and exploded. It was the most serious accident after the Chernobyl nuclear accident, ranked level 7 on the international nuclear level scale. Research showed that this accident was caused by the Tohoku earthquake and the tsunami followed by. When the detectors in the nuclear plants detected the earthquake, it shut down the power supply to the reactors in order to protect them. However, the remain heat in the reactors can only be cooled down by the circular pipes around the nuclear plant. Unfortunately, a tsunami followed and attacked the seawalls of Fukushima, causing hydrogen explosions and melt down of the reactors. The accident resulted in total death of more than 19 thousand

people and 154000 citizens evacuated from towns nearby. More threatening than the death toll was the nuclear pollution caused by the leak of dangerous radioactive substances and contaminated water. Later, isolation, preservation and disposal of the contaminated water became a big problem for Japanese government because the water is dangerous to the environment and very hard to degrade. Plus, the water tanks were almost full now.

Cause of the problem

The major cause of the nuclear pollution is contaminated water. The water was contaminated through the cooling process. When the nuclear reactors melt down, the temperature of the nuclear plant rose dramatically, forced the government to use water to absorb the heat and cool down the plant. The water used for cooling process contained tritium, a radioactive form of hydrogen. Tritium is a byproduct of nuclear reaction. When the reactors process and chain

reaction, a chemical named boron is used to absorb neutrons. This chemical is blended with water during the cooling process and eventually become tritium. It is important to note that tritium existed in natural world and is identical to the one generated by nuclear reaction. In fact, study shows that the amount of tritium in contaminated water is 50 times lower than natural radioactivity and 5000 times lower than one CT full body check, which should be completely harmless to human body. Besides, small amount of tritium can be absorbed by the environment and have little impact on the local environment. However, during a nuclear accident like the one in Fukushima, large amount of tritium was contained in the water and leak into the ocean, affected the ecosystem and environment in large areas. It is also very hard to remove tritium from water with current technology. As a result, Japan had to store large amount of contaminated water by water tanks. There are about 1.3 million tons of contaminated water stored in more than 1000 tanks and the amount is increasing at a rate of 140 tons per day. According to Japanese government, all the tanks will be full by 2022.

Effects of the problem

Different than what is initially expected, contaminated water has much larger impact on the environment and the ecosystem than on human body. During the first several days of the accident, large amount of heat water contained iodine-131 were released into the ocean nearby. This kind of isotope is particularly vital to sea animals. The water also contained radioisotopes such as Cesium and Zinc that are dangerous to maritime animals and plants. Besides, water leaked from the reactors is very hot. The high temperature will fasten the metabolism process of fish and other sea creatures, resulted in tense competition

for limited natural resources. Radioactive substances in contaminated water can also destroyed cell structures in plants and animals and cause genetic mutation. In sea area near Fukushima, mutant butterflies, bugs and birds were found and study showed that the mutation was linked to the accident. The radioactive substances not only cause genetic mutation, but also led to decay in soil infertility and lost of nutrition. This means that the ecosystem around the nuclear plant was basically destroyed. Moreover, the most influential radioactive substance, cesium, has a half life of 30 years, which means the impact is going to last for long. As a result of these negative effects, Japan has to store the water and find ways to decompose it instead of discharging the water into the ocean.

Solution

Japan has already had several attempts to clean the residue and purify the contaminated water. But none of them solved the problem. Initially, the government used remote robots to clean up the residue of radioactive substances in the remains. The technology at that time was advanced enough to support the robots to compete such complicated task, but they frequently lost connection and run out of power because of the high temperature in the building. This method was partially successful but did not solve the problem of contaminated water. Later, the government decided to store contaminated water in large tanks and decompose it gradually. This method satisfied other countries and environmentalists for the first several years. Although a Japanese professor came out with aluminum filter to separate tritium and water, it has not been applied widely yet. Japan reports that there will be no more storage by 2022, which means a solution is necessary and urgent.

Recently, Japanese government announced to release the contaminated water into the Pacific Ocean, a solution to the storage problem. Japanese government claimed that the water will be diluted and only left small concentration of tritium in it, which has minimum impact on the environment. However, Chinese, and Korean government strongly opposed Japanese decision, argued that the water is still highly contaminate and the ocean is not Japan's trash can. There is no information about which way Japanese use to dilute other dangerous radioactive isotopes and chemicals from the water. But there are two possible ways that might be successful and efficient.

A plausible method is electro filtration. It is a method that use electros on the traditional membrane method. Although the fundamental principle of this method is still separating substances through membranes, the presence of electros can significantly facilitate the process because they can create electro fields. The electro fields will create polarity, which generates electrophoretic force to counter the resistant force in the membrane, reduce the time of the process. Electro filtration can be used in media filtration or membrane filtration, and the latter one is the traditional method to dilute contaminated water. This method is called ultrafiltration. However, there are by products of this process and might pollute the environment though the membrane itself can be electrode and fasten the process even more.

Electro filtration is initially designed to separate biopolymers. However, researchers found out that this method is useful for wastewater as well. The reason is that biopolymers typically

contain amino and carboxyl, which are hard to separate by traditional methods but easier with electro boost. Nuclear wastewater contains amino too. When dilute contaminated water that cannot be decomposed by regular method, a combination of electro filtration and other methods might work. For instance, a dead-end filtration plus an electrical field enhancement can efficiently remove phenol from wastewater. It is possible that some other combinations of electro fields and traditional membrane methods can remove tritium from contaminated water in the tanks.

Conclusion

Nuclear pollution is still one of the major environmental impacts on the ecosystem and the world. And contaminated water plays an important role in it. The water used to cool down the reactors during the Fukushima accident contained large number of radioactive substances, which make it potentially dangerous to the environment. Therefore, Japanese government had to store it into large tanks. However, the storage will be running out by 2022, so they must find an alternative. Japanese already decided to pour the water into Pacific Ocean because they claimed that it is harmless. But this solution is opposed by many countries. Therefore, two methods are introduced to be possible solutions to dilute tritium, a substance opposed strongly by environmentalist, from contaminated water. The first method is electro filtration. It can improve the efficiency of the process of traditional membrane method. The other method is aluminum filter, invented by a Japanese science team and plan to apply it.

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