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Nuclear Waste Disposal

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Nuclear energy is one of the most controversial energy sources we have. For some people, the potential risk associated with nuclear power is too high. For others, nuclear looks like the answer for a zero-carbon future with high energy density. Unlike solar and wind energy, which need the sun to be shining or the wind to be blowing, nuclear power can be generated at any time throughout the day. This means that a nuclear power plant can produce energy nonstop, and you won't have to experience any delays in energy production. With a carbon-free future in mind, entrepreneurs and startups are leading the way toward the next generation of nuclear. Nuclear energy is formed by splitting uranium or plutonium atoms through chain reactions in a nuclear reactor by a process called 'nuclear fission'. The energy released from splitting the atoms is used to heat water into steam. This steam then turns a turbine, which creates usable electricity.

The main problem of nuclear energy is radioactive waste generated in the process. I am going to look into the ways of disposing of nuclear waste to get full advantage of this type of energy.

Radioactive waste includes any material that is either intrinsically radioactive, or has been contaminated by radioactivity, and that is deemed to have no further use. Government policy dictates whether certain materials – such as used nuclear fuel and plutonium – are categorized as waste. Every radionuclide has a half-life – the time taken for half of

its atoms to decay, and thus for it to lose half of its radioactivity. Radionuclides with long half-lives tend to be alpha and beta emitters – making their handling easier – while those with short half-lives tend to emit the more penetrating gamma rays. Eventually all radioactive waste decays into non-radioactive elements. The more radioactive an isotope is, the faster it decays [1].

Radioactive waste is typically classified as either low-level (LLW), intermediate-level (ILW), or high-level (HLW), dependent, primarily, on its level of radioactivity.

Talking about low level waste, waste management is separated in 3 types: Low level Waste which has a much shorter radioactivity life than the others. Second is intermediate level waste which has been exposed to alpha radiation, or contains long-lived radionuclides, it constitutes 33% of the waste. This type of waste needs shielding and containment for period over 100 years. Finally, the most dangerous type is high level waste responsible for 36% of the waste, it results from burning uranium fuel. High Level Waste is composed from used fuel that has been designated as waste, and separated waste from reprocessing of used fuel (Figure 1) [2].

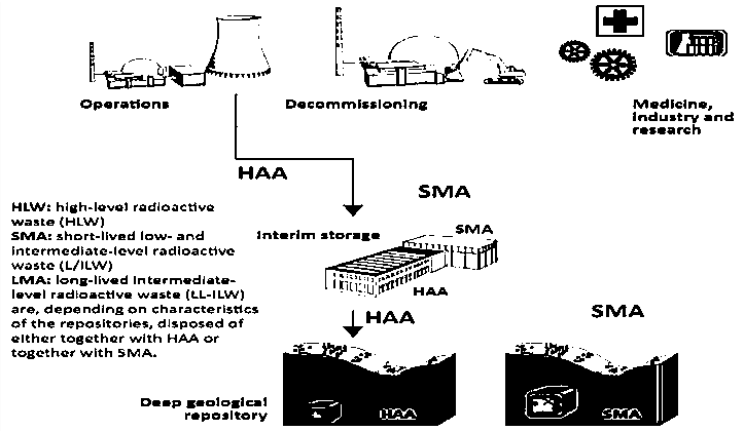

Figure 1 – Treatment of nuclear waste

Treatment involves operations intended to change waste streams' characteristics to improve safety or economy. Treatment techniques may involve compaction to reduce volume, filtration or ion exchange to remove radionuclide content, or precipitation to induce changes in composition.

It is important to note that, while treatment processes such as compaction and incineration reduce the volume of waste, the amount of radioactivity remains the same. As such, the radioactivity of the waste will become more concentrated as the volume is reduced. The combustible elements of both radioactive and other wastes can be incinerated to reduce volume.

Currently, there are three options widely used to store nuclear waste. First option is to store it in temporary pools or dry casks, the method is the following, after the fuel is being used it's placed in water pools for ten years to decrease its radioactivity, then it's contained in dry storage containers for a 50-year period. Second option is to bury the waste deep underground for hundreds of thousands of years, it's called "deep geological repository". This is the safest way for the environment and humans. The third option is to reprocess spent fuel for re-use, it can separate out usable uranium and plutonium. Reprocessing sounds like the best solution as it's recycling the nuclear waste; however, that's not the case because this method is very risky for the global stability [3].

It's a societal problem that has been handed down to us from our parents' generation. And we are – more or less – handing it to our children. Regardless of whether you are for or against nuclear power, and no matter what you think of nuclear weapons, the radioactive waste is already here, and we have to deal with it.

References:
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2. Kenneth L. Nash and Gregg J. Lumetta. Advanced Separation Techniques for Nuclear Fuel Reprocessing and Radioactive Waste Treatment. – Woodhead Publishing. – 2011. – 512 p.
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