Nuclear Transmutation for Radioactive Waste Disposal

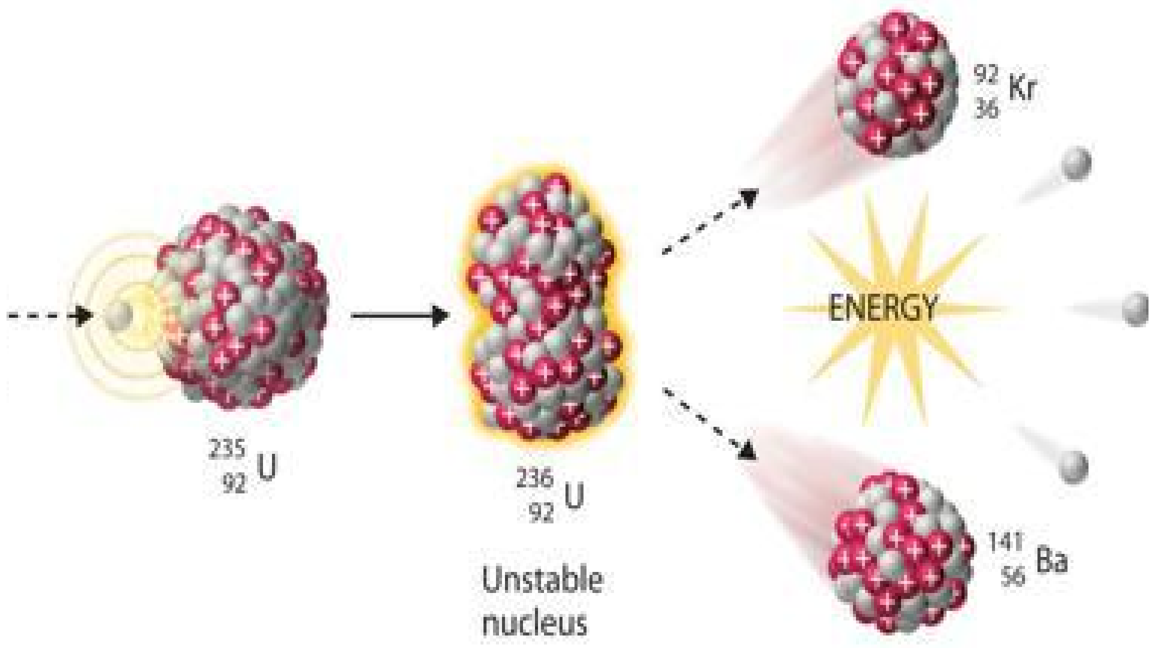

Figure 1. Example of nuclear transmutation (U-235 → Kr-92 & Ba-141)

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INTRODUCTION

Nuclear transmutation is the conversion of one chemical element into another.

This technology is quite similar to alchemy. In this article, we'll learn how it's used and why it's used for radioactive waste disposal.

MAIN

There are three types of radioactive waste: low-level waste, intermediate-level waste, and high-level waste. This waste is produced in a nuclear power plant, which makes up about 10% of total energy (for some countries, it's over 30%); therefore, we can't stop using nuclear power plants, so we should think about how to remove radioactive waste, especially high-level waste. One way is nuclear transformation. As I said in the introduction, we can use nuclear transmutation to convert one element into another, for removing radioactive waste, conversion of high-level wastes to low/intermediate level waste, or other uses. Nuclear transmutation technology can ensure waterproof storage for 1000 years, reducing the amount of high-level waste by 80% in the process.

PROS AND CONS

The pros, as mentioned earlier, are that transmutation can reduce two things: the huge amount of time needed to remove waste, and the huge amount of waste.

The cons are that the practical method of obtaining and controlling neutrons is very limited, and the only alternative at present, which is the method of obtaining neutrons by proton acceleration, is fundamentally very low in efficiency.

PROSPECT

Nuclear conversion technology is being studied in two main ways. The first method is by using a fast reactor. This uses high-speed neutrons to divide long-lived nuclides into new nuclides. The second is the accelerator-driven non-critical system (ADS). In this method, a particle accelerator collides high-energy protons with the target metal to generate a large amount of neutrons, which causes nuclear transformation. ADS has the advantage of a low risk of runaway and high safety because the reactor does not reach a critical state. However, technical limitations and economic problems also exist. Operating the accelerator and high-speed path requires enormous energy, complex processes, and high-cost equipment. In addition, the management problem of secondary radiation or new nuclides generated during the conversion process must be solved. Therefore, many view nuclear transformation as an auxiliary technology that must be combined with existing treatment methods (re-treatment, long-term storage, etc.) rather than a 'miracle technology' to eliminate waste alone.

CONCLUSION

Nevertheless, nuclear transformation is seen as a promising solution to alleviate the nuclear waste problem facing humanity. If safety and economic feasibility are improved, nuclear conversion technology will play a key role in building a sustainable nuclear circulation system for the future use of nuclear power.

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