Generation IV Nuclear Reactors: Safety and Efficiency

Vorwissenschaftliche Arbeit verfasst von

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Klasse 8B

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Abstract

This is a placeholder for the abstract. It summarizes the whole thesis to give a very short overview. Usually, this the abstract is written when the whole thesis text is finished.

Contents

1 Basic concepts of nuclear power

Nuclear power reactors harness the heat generated by splitting atoms of certain elements in a controlled and predictable way. This heat is used to create electrical power[1].

1.1 Fission

Nuclear fission is the spontaneous or induced reaction, by which an atom is broken up. In the case of nuclear power reactors these reactions are exothermic. Nuclear radiation such as 1.1 already liberates a large amount of energy.

$$^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th}, \quad P = 8 \cdot 10^{-9} \, \frac{W}{g} \tag{1.1}$$

This power is increased in nuclear reactors by 10 orders of magnitude. Although the effective lifespan is lowered from $4.468 \cdot 10^9$ years to a few months. Therefore fission is the main reaction trough which nuclear reactors generate the majority or their power output. An example of such a reaction is given in 1.2.[2]

$$\begin{aligned} {}^{235}_{92}\mathrm{U} + n &\rightarrow {}^{236}_{92}\mathrm{U} \\ {}^{236}_{92}\mathrm{U} &\rightarrow {}^{144}_{56}\mathrm{Br} + {}^{39}_{36}\mathrm{Kr} + 3n + 177 \; MeV \end{aligned} \tag{1.2}$$

It is important to note that 1.2 is a simplification of the actual decay series of $^{236}_{92}\mathrm{U}$ into stable end products. 1.2 is sufficient to understand the principle

[1] World Nuclear Association, 2022.
[2] Basdevant, Rich, and Spiro, 2005, p. 286.

behind nuclear fission. The decay series of $^{236}_{92}\mathrm{U}$ with no intermediates removed is given in 1.3.[3]

$$
\begin{aligned}
^{236}_{92}\mathrm{U} &\rightarrow {}^{137}_{53}\mathrm{I} + {}^{96}_{39}\mathrm{Y} + 3n \\
^{137}\mathrm{I} &\rightarrow {}^{137}\mathrm{Xe} + e^- + \bar{v}_e, \quad t_{1/2} = 24.5s \\
^{137}\mathrm{Xe} &\rightarrow {}^{137}\mathrm{Cs} + e^- + \bar{v}_e, \quad t_{1/2} = 3.818m \\
^{137}\mathrm{Cs} &\rightarrow {}^{137}\mathrm{Ba} + e^- + \bar{v}_e, \quad t_{1/2} = 30.07y \\
^{96}\mathrm{Y} &\rightarrow {}^{96}\mathrm{Zr} + e^- + \bar{v}_e, \quad t_{1/2} = 5.36s
\end{aligned}
\tag{1.3}
$$

[3] Basdevant, Rich, and Spiro, 2005, p. 287.

Appendix

Bibliography

Basdevant, J.L., J. Rich, and Michael Spiro (2005). *Fundamentals in Nuclear Physics: From Nuclear Structure to Cosmology*. Advanced Texts in Physics S. Springer. ISBN: 9780387016726. URL: https://books.google.at/books?id=jIObNOGKiKkC (cit. on pp. 1, 2).

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Eidesstattliche Erklärung

Ich, Elias Leitinger, erkläre hiermit eidesstattlich, dass ich diese vorwissenschaftliche Arbeit selbständig und ohne Hilfe Dritter verfasst habe. Insbesondere versichere ich, dass ich alle wörtlichen und sinngemäßen Übernahmen aus anderen Werken als Zitate kenntlich gemacht und alle verwendeten Quellen angegeben habe.

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