Nuclear Physics

Mainly notes from 'Introductory Nuclear Physics' Krane

Controlled reactions

- If we just had a fine powder of Uranium and mixed it with the moderator, like Carbon. As you reduced the energies of the neutrons it becomes more likely to be captured by the 238 Uranium. To prevent this, we need the neutrons to enter at least 19cm of graphite to become thermalized.
- Graphite has a very small thermal cross section but we still need to get neutrons back into the Uranium fuel.

Four factor formula

- $k_\infty = \eta \epsilon p f N$
- ϵ is the number of fission neutrons caused by thermal neutrons.
- If we have an original generation of N thermal neutrons. If v is the number of neutrons produced in a fission reaction of element.
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    $$\eta = v \frac{\sigma_f}{\sigma_f + \sigma_a}$$
  - Where ϕ_f and ϕ_a are the fission cross section and other absorptive cross section respectively.
  - After this first process you're left with ηN neutrons which must be thermalized.
- The ηN fast neutrons have an non negligible cross section for fission with 328 Uranium this causes a further increase in neutrons produced from our initial N generation. The fast fission factor is ϵ
- As mentioned above resonance capture can occur with 238 during moderation, this is accounted for with p the resonance escape probability.
- The thermal utilization factor f is a measure of thermal neutrons that are actually available to the U^{235} and U^{238}.
- The number of neutrons remaining is the $\eta \epsilon p f N$.

Why 235 rather than 238