How long may the world rely on nuclear fission power?

The document needs to provide a specific answer to this question. However, it does state that by implementing a self-sustaining power system through breeding, the world's currently assured uranium fuel resources can be extended from about a century to beyond 10,000 years. (Page 1)

Where do these fuel resources reside?

The article needs to provide specific information on where these fuel resources reside. It mainly discusses the different fuel types and their properties of fast neutron Generation IV reactors. (Pages 5-7)

Which is the maximum concentration of 233U permitted to obtain CRip > 1.0?

The maximum concentration of 233U permitted to obtain CRip > 1.0 is 1.53%. This information can be found in page 3 of the document "Fast Neutron Generation IV Reactors" by J. Wallenius & S. Bortot.

Fissile mass at EoL < BoL! It contradicts the conventional definition of breeding. How and why?

The statement that Fissile mass at EoL < BoL contradicts the conventional definition of breeding because conventional breeding refers to producing more fissile material than what is consumed. If the fissile mass decreases from the beginning of life (BoL) to the end of life (EoL), more fissile material is consumed than produced. Hence the reactor is not effectively breeding. This concept is discussed in the background section of Chapter 2 on the Physics of breeding in the document "Fast neutron Generation IV reactors" by J. Wallenius & S. Bortot on pages 2-3.

A better neutron economy makes breeding with high burn-up possible. Burn-up is limited to approx.—10% by damage dose to fuel cladding, not by reactivity. U-Pu cycle features a better reactivity margin. why?

Better neutron economy, achieved through a fast neutron spectrum and a U-Pu fuel cycle, increases breeder reactors’ burn-ups. The burn-up is limited to approximately 10% by damage dose to the fuel cladding rather than by reactivity. The U-Pu cycle features a better reactivity margin due to the higher fraction of fissile isotopes present in the fuel. This information can be found on pages 7 and 8 of the document.

But why does the U-Pu cycle features a better reactivity margin?

The U-Pu cycle features a better reactivity margin because it yields a higher conversion ratio, which means a lower fraction of fissile material is required to achieve the same reactivity at the beginning of life and after reprocessing compared to the Th-U cycle. This results in greater flexibility in terms of core design and a higher burn-up. This information can be found on page 8 of the document.

How is reducing power density reduce the conversion ratio?

Reducing power density in high-density fuels leads to a larger reduction in capture cross sections than in fission cross sections, reducing the conversion ratio compared to oxide fuels. This fact has only sometimes been well understood in the literature. (Pages 17-18)

what is a "harder neutron spectrum"?

A "harder neutron spectrum" refers to neutrons with higher energy levels capable of inducing fission in a wider range of isotopes, including fertile isotopes. This results in a higher likelihood of breeding fuel in fast neutron reactors than in thermal reactors. This concept is discussed in pages 5-6 of the document.

Why is the average number of neutrons produced in an absorption > 2.0 not a requirement for breeding?

An average number of neutrons produced in an absorption greater than 2.0 is not the sole requirement for breeding because it does not consider the losses of neutrons due to parasitic absorption and leakage. The breeding potential also depends on other factors, such as the reactor's power density, neutron spectrum, and fuel composition, as discussed in this chapter on page 25.

What are the limitations of breeding fissile fuel in a thermal spectrum reactor?

The limitations for the breeding of fissile fuel in a thermal spectrum reactor include the production of higher isotopes of plutonium, which act as strong absorbers, and a significant reduction in the breeding ratio due to the competition between the production of fissile fuel and the burning of fissile fuel through fission. This information can be found on page 2 of the document.

Explain why a reactivity-based criterion is required to assess the breeding potential in a fast spectrum.

A reactivity-based criterion is required to assess the breeding potential in a fast spectrum because the breeding process involves the creation of new fissile material through the capture and subsequent conversion of neutrons. Therefore, the breeding efficiency depends on the reactor's overall reactivity, which needs to be larger than zero over burn-up, cooling, and reprocessing. This is explained on page 8 of the document.

What determines the breeding efficiency of different fuel compositions?

The breeding efficiency of different fuel compositions is determined by neutron spectrum, power density, and the reactivity of the fuel. The choice of coolant used in the reactor can also impact breeding efficiency. More information on this topic can be found in the "Physics of breeding" section of the document, specifically in the Background and Breeding Ratio subsections on pages 1 and 2.

Set up the Bateman equations for breeding of 239Pu from 238U and calculate the equilibrium composition assuming a sufficiently long irradiation time.

The Bateman equations for breeding 239Pu from 238U can be expressed as a system of differential equations. These equations can describe the rate of change of the number of atoms of each nuclide in the chain. The equilibrium composition can be calculated through numerical integration, assuming a sufficiently long irradiation time. This information can be found in section 2.3 of the document "Fast neutron Generation IV reactors" by J. Wallenius & S. Bortot (pages 26-28).