Abstract

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The Nuclear Fuel cycle

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Abstract

Nuclear fuel, usually made from uranium, is one of the most dense fuel sources available. A single pellet of uranium fuel, weighing just six grams, has about as much energy available in today's fission reactor as 3 barrels of oil (42 gallons each), 1 ton of coal, or 17,000 cubic feet of natural gas.
For more than fifty years, the nuclear fuel cycle has contributed to clean energy in the United States and around the world. The nuclear fuel cycle relies on uranium, a relatively common and abundant element, and consists of the processes and industrial operations required to extract usable energy from uranium. When reprocessing and recycling of used nuclear fuel (UNF), also known as spent nuclear fuel, is included as a part of the fuel cycle, a truly repeatable loop is created.

1. Recovery (mining and milling) – up until several decades ago, most uranium was recovered using open pit mining. Now, in-situ recovery is the predominant form of uranium recovery. Chemicals that dissolve uranium are pumped into bore holes. The solution is then pumped to the surface. This process reduces worker exposure to the uranium and lowers costs. The recovered uranium is processed in a mill into a uranium oxide (U2O3) concentrate, sometimes called "Yellow Cake."

2. Conversion – uranium oxide is converted into uranium hexafluoride (UF6) in preparation for enrichment.

3. Enrichment – two isotopes of Uranium, U-235 and U-238, make up the majority of all uranium ores found in nature. Of these two isotopes, U-235 drives the fission reactions in nuclear reactors and makes up less than 1% of natural uranium. Compared to natural uranium, enriched uranium has more U-235; depleted uranium has more U-238. Light water reactors in the United States and around the world use low-enriched uranium, around 3-5% U-235. Enrichment processes usually use centrifuges or gaseous diffusion. The difference in weight between the isotopes separates them.

4. Fuel Fabrication – reactor fuel can take many forms but traditionally takes the form of ceramic uranium dioxide (UO2). Pellets of fuel are stacked within sealed metal tubes, which are then assembled into a bundle of steel rods, called a fuel assembly.

5. Energy Generation – the fuel is put into the reactor core, where it can be used for varying amounts of time based on design and operation. Most fuel spends around 4 or 5 years generating energy within a reactor core. The used fuel assemblies are then removed from the core.

6.Interim Storage – used nuclear fuel remains both hot and radioactive after operation within a reactor. Large pools of water--fuel pools--are used to cool and shield the fuel; they usually hold fuel for about 10 years. In the United States, this is where the nuclear fuel cycle currently ends. As fuel assemblies cool, they are moved to dry casks--huge sealed concrete containers--for storage and air cooling at the reactor site.

7. Reprocessing* – used nuclear fuel still contains about 95% of its original uranium and the overall U-235 content has only slightly decreased. Reprocessing can extract the useable uranium and plutonium (created in the fissioning process), which can then be recycled as new fuel for current and future reactors. By reprocessing and recycling, waste volumes and their longevity can be drastically reduced.

8. Vitrification - any liquid waste from reprocessing is heated to powder and the immobilized in glass. This glass can then be poured into long-term storage canisters for transport or storage.

9.Long-term Isolation - whether reprocessing or not, some byproducts of the nuclear fuel cycle, known in the United States as high level waste (HLW), will require final disposal. Currently, geologic isolation, where the byproducts are placed in stable rock formations hundreds of feet below ground, is the final disposal plan for many nations. Numerous nations are constructing or siting such repositories.

Biography

Sharmista suman nanda did PhD in School of technology and Science, Narayana Technological University, Bangal